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NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

29879 (IA-822) RESEARCH LABORATORIES SEMI-ANNUAL REPORT, JULY–DECEMBER 1962. (Israel. Atomic Energy Establishment, Rehovoth). May 1963. 159p.

Results are reported from the following studies: operation and fast-neutron spectrum of the Israel research reactor; loading of nuclear emulsions with lithium; nuclear temperatures; critical-mass calculations on ZPR-III critical assemblies; nuclear resonant scattering of γ rays; (n,α) reactions on Te^{120} and Te^{123}; electron spin resonance spectra of Er^{3+} in CaF_2; thermoluminescence and electric current glow curves in diamond; anion exchange of metal complexes; chemistry of Np(III) in solution; trivalent actinides in nitrate solutions; dissociation and stability constants of imino acids; absorption spectra of erbium and neodymium nitrates; thermodynamics of fluids in electrostatic fields; radiolysis of aqueous solutions of ethylenediamine using x radiation; trans-tritiation induced by nuclear transformations; decay of Zn^{71}; recoil labeling of methyl iodide; preparation of carrier-free Br^{82}; preparation of highly tritiated alanine; effects of repeated 50-r total-body exposures on the blood picture of rats; fallout monitoring in Israel; pulse-rate change indicator; multichannel analyzer for low-rate phenomena; and a fast shuttle rabbit system. (L.T.W.)

29880 (WT-801) EFFECTS OF AN ATOMIC EXPLOSION ON UNDERGROUND AND BASEMENT TYPES OF HOME SHELTERS. Joseph B. Byrnes (Federal Civil Defense Administration, Washington, D. C.). Oct. 1953. Project 21.1 [of] OPERATION UPSHOT-KNOTHOLE. 49p.

Underground earth-covered shelters were exposed to a 16.4-kt, 300-ft tower shot at ranges of 1230 ft (one), 1450 ft (one), 1800 ft (five), and 3500 ft (one). Two types of basement shelters were constructed in each of the test houses at 3500 and 7500 ft. Instrumentation was by gamma-radiation badges, paraffin cubes, and nylon swatches. Attempts were made to measure permanent deflections of concrete roof slabs. Mannequins were placed in several shelters for purposes of demonstration and observation of blast-caused movement. A weighted mannequin in the underground shelter at 1230 ft was broken in half; an unweighted one (child size) was thrown to the floor. All other mannequins remained in place, undamaged. Paraffin cubes and nylon swatches showed no evidence of thermal damage. Fallout conditions made it impossible to determine initial gamma-radiation quantities. There was no cracking or permanent deflection of the concrete roof slabs. Except for a wood-covered, trench type shelter, which partially failed because of faulty construction, the shelters showed no blast damage. Thermal energy entering the shelters probably would not have caused skin burns to human occupants. Adequacy of the shelters under full design loads could not be determined because pressures were lower than expected, but the shelter designs were structurally acceptable under test pressures received. (auth)

29881 (WT-810) EXPOSURE OF DRUGS TO NUCLEAR EXPLOSIONS. Edwin P. Laug (Food and Drug Administration. Div. of Pharmacology. Physiochemistry Branch). Nov. 1953. Project 22.4 [of] OPERATION UPSHOT-KNOTHOLE. 21p.

A representative selection of 42 common drug preparations was exposed to the action of nuclear radiation and blast at two shots in the Upshot-Knothole series in Nevada in the spring of 1953. The drugs were packaged in the form in which they would be found on drugstore shelves and were exposed to various levels of neutron and gamma radiation ranging up to 50,000 r. Insulin and vitamin B_{12} were reduced in potency by about 10 and 50 per cent, respectively, but no other preparation tested showed any deterioration. Some of the drugs showed a moderate level of induced radioactivity. This activity was traced either to an actual mineral constituent of the drug itself, as in the case of thiopental sodium, or to an excipient, such as calcium phosphate used in aureomycin. However, the level of activity was so low that little or no radiological health hazard would be involved in the normal use of the exposed drugs, although those with a high sodium content should be allowed to cool for several days before using them. Any drugs in containers remaining physically undamaged at a distance of 1000 yd from the explosion of a nominal atomic bomb are considered entirely safe for immediate use. Under heavy exposure the glass containers in which the drugs were packaged displayed strong but short-lived activity due to their sodium content. Clear glass also showed a marked darkening. None of the closures failed, and none of the closure materials deteriorated chemically or biologically under the conditions of the tests. (auth)

29882 (WT-1162) EFFECTS OF A NONIDEAL SHOCK WAVE ON BLAST LOADING OF A STRUCTURE. L. J. Vortman (Sandia Corp., Albuquerque, N. Mex.). May 1956. Project 34.2 [of] OPERATION TEAPOT. 46p.

A 6- by 6- by 36-ft structure was subjected to a nonideal wave front with an overpressure of about 14 psi at 1850 ft from a 43 ± 2 kt, 500-ft tower burst. The structure was demolished by the blast, but records were obtained for an average of 580 msec before the signal cables were torn out or broken. The precursor was weaker than expected. Peak overpressures on the front of the structure were in excess of 100 psi, indicating an unexpectedly high contribution from the drag pressure. (auth)

29883 (WT-1174) GAMMA- AND NEUTRON-RADIATION MEASUREMENTS. L. J. Deal (Division of Biology and Medicine, AEC). May 1957. Project 39.1 [of] OPERATION TEAPOT. 79p.

Results are presented from film dosimeters and gold and sulfur threshold detectors used to measure gamma radiation neutron fluxes. The bulk of the data reports the results of measurements in various shelters and homes. The data are presented in tabular form by project number and shot name in Appendix A. The report also contains results of studies on the effects of neutrons on film dosimeters. (auth)

29884 (WT-1501) BLAST MEASUREMENTS FOR CETG PROJECTS. J. J. Meszaros, J. H. Keefer, and J. D. Day (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Apr. 1960. Project 39.2 [of] OPERATION PLUMBBOB. 87p.

Measurements were obtained of static and dynamic pressures both inside shelters and in the free field. Self-recording instrumentation was used for most of the measurements, and some electronic measurements were taken. The project participated in eight shots with varying numbers of instrumentation channels. On several shots complete blast-line instrumentation was obtained. A total of 97 overpressure and 34 dynamic-pressure channels was provided. Good overpressure–time data were obtained on 80 channels; 11 channels gave peak pressure only; and 6 channels produced poor or no records. Good dynamic-pressure–time data were obtained on 20 channels; 10 channels gave peak values; and 4 channels produced poor or no records. Pressure data obtained in various portions of ventilation systems were checked against existing shock-tube data on scale-model pipe and tunnels systems. A prediction method for the shock-front pressure and the pressure–time curve in the chamber was correlated with the field results. Also, a prediction of the shock diffraction and resulting drag pressures on ventilation filters is presented. The deleterious effects of ground motion on the occupants of a blast shelter are discussed. An experiment to test the effectiveness of Ensolite as an alleviator of ground-motion damage is described. The results are limited but show some promise for Ensolite as a floor covering. (auth)

29885 PROCEEDINGS OF THE 4TH CONFERENCE ON RADIOISOTOPES, OCTOBER 1961, TOKYO, JAPAN. (Japan Atomic Industrial Forum, Inc., Tokyo). 1961. 1161p.

Two hundred thirty-three papers are included; separate abstracts have been prepared for 151. Five papers were previously abstracted in NSA. The remaining 77 papers are concerned with the uses of radioisotopes in engineering, chemistry, tracer techniques, medicine, biology, and agriculture. (T.F.H.)

29886 INDUSTRIAL NEUTRON MOISTURE GAUGE. Takashi Sato, Tetsuo Sumi, and Takashi Maruyama (Naka Works, The Hitachi, Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 169-73(1961). (In Japanese)

A neutronic moisture gauge, which had Ra–Be as the neutron source and BF_3 proportional counters as the detector, was examined with the view of using it for industrial application. (T.F.H.)

29887 A MOISTURE METER. Kazuo Miyakawa (Fuji-Seitetsu Co., Ltd.), Yukio Okikawa, Hirohide Miwa, and G. Toyama. Proc. Japan Conf. Radioisotopes, 4th, 173 (1961). (In Japanese)

The moisture content of ore of iron is measured. The sample contains mainly Fe_2O_3 (Fe 60%, C 4%). The sample, whose moisture content is known, is put in a container of 40 cm × 40 cm × 70 cm in depth, and in its center a moisture probe of scintillation type is inserted. The probe is connected to a linear rate meter. The moisture probe consists of a LiI(Eu) scintillator of 2.5 cm diameter × 1.3 cm thickness. RaD(5mc)-Be is employed as the fast neutron source, because the LiI scintillator is very sensitive to gamma radiation. (T.F.H.)

29888 SOME APPLICATION EXAMPLES OF RADIOISOTOPES AS A RADIATION SOURCE TO THE FIELD OF CIVIL ENGINEERING. Akira Ariizumi, Osamu Kondou, and Yoshinori Mori (Public Works Research Inst., Ministry of Construction). Proc. Japan Conf. Radioisotopes, 4th, 174-7(1961). (In Japanese)

Application examples of moisture and density gages equipped with radioisotopes as neutron or gamma sources, for civil engineering applications, are reported. (T.F.H.)

29889 GAS ANALYZER AND GAS DENSITOMETER. Hiroshi Imamura, Junro Tsujii, Makoto Yokooji, Hiroshi Tominaga, and Tokio Oshima (Central Research Inst., Ube Industries, Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 193-7(1961). (In Japanese)

Soft-x-ray absorption in a substance depends upon the atomic number of the substance. This fact is applicable for measuring the concentration of a component in a gas mixture, when the atomic numbers of the components differ adequately from each other. γ or β absorption (stopping power) varies approximately with the density but not with the element of the substance. It is therefore possible to measure the density of the gas. Theoretical considerations and experiments are done on the binary system SO_2–N_2, as a typical example. (T.F.H.)

29890 FUEL TEST BY THE X-RAY ABSORPTIOMETRY USING RADIOACTIVE ISOTOPES. Shigemasa Enomoto, Tomihiko Furuta, and Chizuo Mori (Nagoya Industrial Research Inst., Agency of Industrial Science and Tech., and Ministry of International Trade and Industry). Proc. Japan Conf. Radioisotopes, 4th, 197-200(1961). (In Japanese)

X-ray absorptiometry with the use of radioactive isotopes was studied. The sulfur content in heavy oil, and the ash content in coal, were determined using a tritium bremsstrahlung source. A radioactive Fe-55 x ray source was also used for sulfur determination in heavy oil. (T.F.H.)

29891 RADIOGRAPHY USING THE SCATTERED γ-RAYS. Tokisi Kaminisi and Yosiyuki Nakasima (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 210-14(1961). (In Japanese)

Experiments are made for the application of scattered γ rays in the labyrinth for shielding of a Co-60 γ ray cave. The scattered γ rays are suitable to the radiography of thin samples, because of their low energy. In contrast with the case of the ordinary point source radiography, the γ rays in the labyrinth come from random directions because of the considerably larger area of the scattering sources and of the complicated shape of the labyrinth. In order to get a parallel beam, the hood should be as long as possible. However, the use of a longer hood requires longer exposure times, because of the decrease of the dose rate. Experiments are made on the exposure diagram, parallelism of the beam in the hood (geometrical unsharpness), and perception sensitivity for various hood lengths (sectional area 100 mm × 100 mm). (JAIF)

29892 AN INVESTIGATION OF THE DISTRIBUTION OF SULFUR IN MILD STEEL WELD-METALS USING AUTORADIOGRAPH. Kazuo Kato and Kozo Nakai (Kobe Steel Works Co., Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 225-8(1961). (In Japanese)

Distribution and segregation of S in mild steel weld metals is studied, using autoradiographs on several sections of weld-beads (weld-metals). In the case of steel ingot, S segregates at the top or the boundaries of dendritic structure. In the case of welding, the cooling rate is so rapid and the molten pool is so small that the distribution of S is somewhat different from that of ingot. S-35 contained in the coatings or core wires of ilmenite type arc-electrodes and in the core wire of automatic welding is transferred into the weld-metals during welding processes. Multi- and one-pass weld metals in manual welding electrodes and one-pass weld metals in automatic welding are examined. Autoradiographs are taken on several sections of these weld metals and compared with their macroscopic structures. (T.F.H.)

29893 ON THE ANALYSIS BY β-RAY BACKSCATTERING. Hisashi Mori and Sadaichiro Taira (Technical Research Inst., Yahata Iron and Steel Co., Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 238-42(1961). (In Japanese)

Beta-particle backscattering from several elements (Pb, Fe, Al, and C) is studied. The beta particles come from collimated Sr-90 sources. The backscattered β ray is detected by a collimated Geiger-Müller counter. The relation between saturation backscattering coefficient G and atomic number of the backscatterer Z is represented by an exponential relation ($G = 1 - e^{-\alpha/Z}$). The difference of backscattering coefficient between each element increases as the scattering angle increases. The absorption curve of scattered β rays from each element shows that the energy of the scattered β ray decreases as the scattering angle increases, especially for low atomic numbers. The effect of a filter is most remarkable when detecting the scattered ray with maximum scattering angle. The hydrogen atom is found to have a negative backscattering coefficient, and to reduce the energy of backscattered rays from the coexisting element (carbon). (T.F.H.)

29894 RAPID DETERMINATION OF ASH IN COAL BY β-RAY BACKSCATTERING. Hisashi Mori and Sadaichiro Taira (Technical Research Inst., Yahata Iron and Steel Co., Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 242-6(1961). (In Japanese)

A rapid method using β-ray backscattering for ash determination in coal is described. The ash component of coal is composed of medium-atomic-number elements such as Si, Al, Fe, Ca, and Mg, whereas the combustible component is composed of low atomic number elements such as C, H, O, and S. Therefore, backscatter intensity from coal should rise with increase of ash content in coal. (T.F.H.)

29895 EFFECTS OF RADIOISOTOPES ON THE IONIZATION CHARACTERISTICS IN OXIDE CATHODE GAS DISCHARGE TUBES. Shiro Ootani and Ren Takahashi (Nippon Electric Co., Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 264-7(1961). (In Japanese)

Generally ionization time of the cold cathode gas discharge tube in complete darkness is increased irregularly, and its operation becomes unstable, because of the lack of primary photoelectrons. For the stabilization of a cold-cathode relay tube with oxide cathodes radioisotopes are used in the tubes, and the effects on their ionization time are measured and analyzed theoretically. (JAIF)

29896 ON THE EFFECT OF γ-IRRADIATION FOR NITRIDING REACTION OF STEEL. Akira Ono, Nobuo Takishima and Wataru Morimitsu (Industrial Research Inst., Kanagawa Prefecture). Proc. Japan Conf. Radioisotopes, 4th, 271-4(1961). (In Japanese)

The radioinduced nitrification of steel is studied. A radiation source of Co-60 of about 1000 C arranged in cylindrical form is used. An electric furnace of cylindrical form with reaction pipe is inserted into the radiation source. (T.F.H.)

29897 γ-RAY INDUCED REACTION BETWEEN GRAPHITE AND CARBON DIOXIDE. Hisao Matsumura, Masamitsu Washino, Tsutomu Watanabe, and Akibumi Danno (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 277-80(1961). (In Japanese)

The effects of pressure, temperature, and electric field on the γ-ray-induced reaction are investigated. Since it is considered that structure of a graphite crystal is scarcely changed by γ irradiation, the contribution of activated species from CO_2 by γ rays to the reaction is measured. In order to obtain information concerning the mechanism of the reaction, experiments from different viewpoints are carried out. (JAIF)

29898 DOSIMETRY OF γ-RAYS BY POLAROGRAPHY. Niro Matsuura (Tokyo Univ.), Yoshimi Kurimura, and Masao Takizawa. Proc. Japan Conf. Radioisotopes, 4th, 281-3(1961). (In Japanese)

The polarographic method is studied as a way of measuring, directly and continuously, Fe(III) and Ce(IV) concentrations in acid solution as they are changed by γ rays. The radiation source is a cylinder of Co-60 of about 800 C. The polarographic cell in which the sample is contained is set in the irradiation chamber. (JAIF)

29899 EXPLOSION BY THE IRRADIATED LIQUID NITROGEN AND OXYGEN. Zen-ichiro Kuri, Shoji Shida, and Shiro Haruhara (Japanese Assn. for Radiation Research on Polymers). Proc. Japan Conf. Radioisotopes, 4th, 284-6(1961). (In Japanese)

When liquid nitrogen (LN) is irradiated by γ rays or high-energy electrons, its color changes to deep blue from the original transparent. If one drop of acrylonitrile is added onto the irradiated LN in a beaker, the acrylonitrile often explodes, in which case the glass beaker is violently broken. If ca. one cc of the irradiated LN is dropped on to liquid acrylonitrile, the drops of LN moving about on the liquid surface evaporate out and the color deepens to dark violet, until an explosive firing occurs and the liquid monomer begins to burn with the aid of the surrounding air. In both the experiments, when the vessel is being poured in an atmosphere of carbon dioxide gas, the explosive sound can be heard but the firing or burning is not seen. Various organic compounds are classified into explosive and nonexplosive groups. The lower limit of dosage for explosion is about 10^6 r, where LN begins to be colored. Temperature of the compounds influences the explosive character. Liquid oxygen behaves as same as LN and its radioinduced coloration is dark greenish purple. Concerning the explosive character, however, it is insensitive up to 10^8 r. (T.F.H.)

29900 EFFECT OF γ-IRRADIATION ON QUARTZ AND SOME SILICATE MINERALS. Ryoiti Kiriyama and Shichio Kawai (Osaka Univ.). Proc. Japan Conf. Radioisotopes, 4th, 286-91(1961). (In Japanese)

The effects of x- and γ-ray irradiation on the dielectric

behavior of some inorganic insulators in the audio-frequency region were investigated. A marked difference of these effects is observed between x- and γ-irradiation on quartz, especially in its c-direction, in the temperature range 200 to 500°C. The results of the irradiation of quartz and beryl on their dielectric losses are summarized and the possible molecular mechanisms are proposed. (JAIF)

29901 RADIATION EFFECT ON THE ELECTRICAL PROPERTIES OF THE NAPHTHALENE CRYSTALS. Kiyokazu Sakaguchi (Osaka Inst. of Tech.) and Tokuo Suita. Proc. Japan Conf. Radioisotopes, 4th, 291-4(1961). (In Japanese)

The changes in absorption spectrum and dielectric breakdown strength of naphthalene crystals were studied as a function of Co-60 γ irradiation. Samples were cut by cleavage from large ingots, and were one to two millimeters thick. They were irradiated in both air and vacuum at room temperature, and the same effects were produced by these irradiated conditions. New absorption bands were created by irradiation. Dielectric breakdown strength of the naphthalene crystal increased with increasing radiation dose; the strength at 5×10^7 r doses was five times larger than that of non-irradiated crystals. (T.F.H.)

29902 SYNTHESIS OF SEVERAL TERTIARY ALCOHOLS FROM PROPANOL-2 AND ETHYLENE BY γ-RAY IRRADIATION. Motoyoshi Hatada (Japanese Assn. for Research on Polymers) and Kozo Hirota. Proc. Japan Conf. Radioisotopes, 4th, 294-7(1961). (In Japanese)

The telomerization processes occurring in the system ethene–2-propanol are studied. 2-propanol and ethylene are distilled into glass tubes, sealed in vacuum, and irradiated with γ-rays with a dose rate of 10^5 r/hr. After the irradiation, the samples are studied in gaschromatographic and mass-spectrometric analyzers. (T.F.H.)

29903 IRRADIATION OF MIXTURE OF PERCHLOROETHYLENE AND ALCOHOLS. Tatsuo Matsuda, Takaari Yumoto, and Kozo Iseda (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 298-301(1961). (In Japanese)

The reaction between perchloroethylene and alcohols is not producible by the methods of photochemistry or by the use of peroxide radical-forming reagents, but it is readily produced by γ irradiation. The main reaction is the 1 : 1 addition reaction. Various chloric alcohols of the 1 : 1 addition products are separable. A mixture of 1 : 4 mole ratio of perchlorcethylene and alcohols is sealed in an ampule, and irradiated at dose rates of 0.16×10^5 to 3×10^5 r/hr with γ rays. The unreacted perchloroethylene and alcohol are distilled after irradiation and the residue is distilled in vacuum, by which means a transparent, viscous residual oil having a moldy odor is obtained. The yields using various alcohols, and the reaction rates of perchloroethylene, are tabulated. (T.F.H.)

29904 REACTION OF BUTENE-1 WITH PHOSGENE INDUCED BY γ-RADIATION. Masaki Takehisa and Masahiko Yasumoto (Government Chemical Industrial Research Inst., Tokyo). Proc. Japan Conf. Radioisotopes, 4th, 301-5(1961). (In Japanese)

The products of the γ-induced reaction of phosgene with 1-butene, and the effect of operating conditions on this reaction, are studied. The reaction products are analyzed by means of gaschromatography, rectification, infrared absorption spectra, analysis of chlorine content, and molecular weight measurement. Hydrogen, ethylene, and hydrogen chloride are found in the gaseous products. In the liquid products, there are small amounts of acid component, which dissolve in aqueous solution of sodium hydroxide. The liquid products that distil up to 115°C (at 5 mm Hg) contain more than eight components, and the molecular weights are between 100 and 200. Each component contains about 20 wt % of chlorine. These components do not contain -COCl groups. This group is found in the higher-boiling fractions. The weight fractions of each component vary with mole ratios of 1-butene and phosgene, and with reaction temperature. (T.F.H.)

29905 GAMMA-RAY INDUCED POLYMERIZATION OF FORMALDEHYDE. Seizo Okamura (Japanese Assn. for Radiation Research on Polymers). Proc. Japan Conf. Radioisotopes, 4th, 305-9(1961). (In Japanese)

Anhydrous formaldehyde was observed to polymerize quite rapidly under γ irradiation, even at very low temperature, into high-molecular-weight polyoxymethylene. (JAIF)

29906 REACTION KINETICS OF RADIATION-INDUCED SOLID STATE POLYMERIZATION OF CYCLIC MONOMERS. S. Okamura, K. Hayashi, Y. Kitanishi, H. Watanabe, and M. Nishii (Japanese Assn. for Radiation Research on Polymers). Proc. Japan Conf. Radioisotopes, 4th, 309-14(1961). (In Japanese)

It is found that the cyclic monomers such as trioxane, diketene, β-propiolactone, 3,3-bischloromethylcycloxabutane, and cyanuric chloride polymerize easily by γ or electron irradiation only in the solid state. It is supposed that some ring compounds, especially the four-membered ring compounds, have a strained structure and may be polymerized within a crystalline lattice if they are properly arranged. (JAIF)

29907 COMPARISON OF THE IRRADIATION EFFECTS OF IONIZING AND ULTRAVIOLET-RAYS IN POLYMERIZATION AND DEGRADATION REACTION. Seizo Okamura (Kyoto Univ.), Masanobu Taniguchi, Takeo Nichi, and Tomonobu Manabe. Proc. Japan Conf. Radioisotopes, 4th, 315-19(1961). (In Japanese)

It seems that the differences in irradiation effects between ionizing and ultraviolet rays are caused by the differences in excited states formed, in which the difference in penetrating power is ignored. The probabilities of decomposition into radicals in these excitation levels, excitation levels related to energy transfer in polycomponent systems, and the rates of energy transfer between these levels are clarified by comparison of the irradiation effects of ionizing and ultraviolet rays. (JAIF)

29908 STUDIES ON GAMMA-RAY-INDUCED POLYMERIZATION IN SOLUTION. Seizo Okamura (Kyoto Univ.), Tadashi Utsumi, and Tomonobu Manabe. Proc. Japan Conf. Radioisotopes, 4th, 320-3(1961). (In Japanese)

Primary radicals produced by γ irradiation are consumed via the chain initiation reaction, reaction with growing chains, and mutual reaction between themselves. In order to obtain exactly the rate of primary radical production, these three kinds of reaction rates are determined. In these reactions, the rate of mutual reaction between primary radicals is so low that it may usually be neglected as compared with the others. (JAIF)

29909 SOLID STATE POLYMERIZATION OF OXETANES BY IONIZING IRRADIATION. Seizo Nakashio (Sumitomo Atomic Energy Industries, Ltd.), Masatsune Kondo, Hiro Tsuchiya, and Masasuke Yamada. Proc. Japan Conf. Radioisotopes, 4th, 323-7(1961). (In Japanese)

Results were obtained about the ionizing-radiation-induced polymerization of chlorine, bromine, and iodine derivatives of 3,3-bis(halogenomethyl)oxacyclobutanes. (T.F.H.)

29910 RADIATION-INDUCED POLYMERIZATION AND COPOLYMERIZATION OF TETRAFLUOROETHYLENE. Hiroshi Sobue (Japanese Assn. for Radiation Research on Polymers), Yoneho Tabata, and Hiroshi Shibano. Proc. Japan Conf. Radioisotopes, 4th, 327-33(1961). (In Japanese)

The radioinduced polymerization of tetrafluoroethylene and the copolymerization of that monomer with ethylene are reported. (T.F.H.)

29911 RADIATION-INDUCED POLYMERIZATION OF MONOMERS WITH TRIPLE BOND. Yoneho Tabata and Hiroshi Sobue (Japanese Assn. for Radiation Research on Polymers). Proc. Japan Conf. Radioisotopes, 4th, 334-7 (1961). (In Japanese)

The polymerizations of methacrylonitrile, acrylonitrile, alkyl cyanide, acetylene, propargylalcohol, and benzene were investigated. (T.F.H.)

29912 RADIOLYSIS OF BIPHENYL—IDENTIFICATION OF RADIOLYTIC POLYPHENYLS BY REVERSE ISOTOPE DILUTION ANALYSIS. Hiroaki Koyama, Genichi Tsuchihashi, and Akibumi Danno (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 337-9(1961). (In Japanese)

In order to obtain information concerning the radiolytic mechanism of biphenyl, reverse isotope dilution analysis was applied to determine the yields of its radiolytic products. Biphenyl-(phenyl C^{14}) was irradiated in vacuum at $100 \pm 5°C$ by γ rays (2.02×10^5 r/hr, 150 hr). After irradiation, the products were separated by column chromatography and purified by recrystallization. Activity of the products was determined. Only the yields of terphenyls and quaterphenyls were determined. (T.F.H.)

29913 STUDIES ON GRAFT COPOLYMERIZATION OF STYRENE TO POLYPROPYLENE BY PRE-IRRADIATION BY γ-RAY IN AIR. Masao Kadonaga, Ko Abe, Kunihiko Iida, N. Ueda, Akira Furuhashi, Hiroshi Matsuo, and Kentaro Matsuyama. Proc. Japan Conf. Radioisotopes, 4th, 340-3(1961). (In Japanese)

Studies on properties of homogeneous graft copolymer of polypropylene-styrene are attempted. As the first step, graft copolymerization by the pre-irradiation method is performed. Effects of atmosphere, temperature, dose rate, and total dose of irradiation, and of temperature and time of polymerization, on the graft percent and the graft efficiency are clarified. Variations of tensile strength and percent elongation of the grafted film with the graft percent are also measured. (JAIF)

29914 RADIATION-INDUCED GRAFTING IN MONOMER VAPOR. Ken-ichi Shinohara and Toshiaki Takamatsu (Inst. of Physical and Chemical Research). Proc. Japan Conf. Radioisotopes, 4th, 344-7(1961). (In Japanese)

The results are studied of graft copolymerization obtained under electron irradiation. The energy of the electrons is 1.5 Mev and the dose rate ranges from 3.14×10^4 to 1.25×10^5 rads/sec. Two series of experiments are carried out. In one series the polymers are irradiated in various monomer vapors, and are then kept at room temperature for various lengths of time in the same monomer vapor. In other series, the polymers are immersed, immediately after the irradiation in monomer vapor, in the monomer liquid and kept in that state for some time. (T.F.H.)

29915 GRAFT COPOLYMERIZATION OF METHACRYLIC ACID ON SYNTHETIC FIBERS BY A PRE-IRRADIATION TECHNIQUE. Tatsuo Matsuda (Government Industrial Research Inst., Nagoya), Keichi Nunome, Yoshiro Sakai, Hiromi Yamakita, and Naruo Maeda. Proc. Japan Conf. Radioisotopes, 4th, 347-51(1961). (In Japanese)

The γ-ray-induced graft copolymerization of methacrylic acid on synthetic fibers, such as nylon, acrylic, polyester and polyethylene fibers, by a pre-irradiation technique in air was studied. The rate of grafting was generally affected by the total dosage up to 10^7 r, while that on acrylic fiber was not so large when the total dosage increased to any high value. As the grafting temperature increased, the rate of grafting also became higher. It was very small, however, below 70°C. Under the same experimental condition, the order of easiness of grafting was as follows: nylon, acrylic, polyethylene, and polyester fibers. (JAIF)

29916 γ-RAY-INDUCED GRAFT COPOLYMERIZATION OF STYRENE ON CELLULOSE ACETATE FIBER. Tatsuo Matsuda, Kiyoshi Hayakawa, and Kaoru Kawase (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 351-5(1961). (In Japanese)

Styrene was graft-copolymerized on cellulose acetate yarns (120 d for 30-filament bundles) by both γ preirradiation and immersion techniques, and the processes of reaction and mechanical strength were discussed from the composition of the grafted fiber. (JAIF)

29917 GRAFT COPOLYMERIZATION FOR POLYPROPYLENE BY PREIRRADIATING IN THE AIR THE SECONDARY ALPHA-RAY PRODUCED BY THE $^{10}B(n,\alpha)^7Li$ REACTION. Masao Umezawa (Asahi Chemical Industry Co., Ltd.), Kozo Hirota, and Zunichi Takezaki. Proc. Japan Conf. Radioisotopes, 4th, 356-9(1961). (In Japanese)

The utilization of slow pile neutrons for the graft polymerization of polypropylene was studied. The experiment was done on polypropylene films of 0.1 mm in thickness. Each sample consisted of three films, enclosed in a polyethylene vessel. Between the first and the second films, a layer of boric acid powder was inserted (20 mg/l cm^2). The films were irradiated in JRR-1 (slow neutron flux $10^{11}/cm^2/sec$, γ rays 10^5 r/sec) for 1 to 15 hours. The films of the second and third layer were used for grafting procedure and their grafting degree was compared, assuming that the second would show the effect of neutrons and γ rays, and the third the effect of γ rays only. Graft copolymers were obtained by use of acrylonitrile and 2-methyl-5-vinylpyridine. (JAIF)

29918 RADIATION-INDUCED GRAFT POLYMERIZATION ON TO CELLULOSE. Toshio Hoshino (Japanese Assn. for Radiation Research on Polymers, Tokyo), Kunio Araki, and Motonobu Ichino. Proc. Japan Conf. Radioisotopes, 4th, 359(1961). (In Japanese)

Dry-state grafting was attempted by means of pretreatment of cellulose before irradiation. Unbleached cotton, bleached cotton, and rayon fiber, chosen as the backbone polymers, were boiled with water, and then the water was substituted with methanol, ethanol, or propanol by boiling at their boiling point. Before the water was replaced by butanol, octanol, acetone, methyl ethylketone, or ethyl acetate by heating at 100°C, the replacement of water by methanol was necessary because of their poor hydrophilic character. Finally, the sample was dried completely in vacuo at 55°C. The grafting was performed by both simultaneous and post-irradiation, the dose rate of gamma rays from Co-60 was 4.0×10^4 r/hr, and the total dose was 4.5 Mr. (JAIF)

29919 RADIATION EFFECTS ON HIGH POLYMERS BY THE IRRADIATION OF γ-RAYS WITH HIGH DOSE. Akibumi Danno, Mitsuru Koike, Kazuo Nagoshi, and Masao Inoue (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 360-4(1961). (In Japanese)

In order to study radiation effects of γ rays with high dose, polyvinyl alcohol, polyethylene, and polytetrafluoroethylene were irradiated over 10^9 r using a Co-60 source. Samples were irradiated in air or in vacuum at room temperature and low or high temperature. Results of gas analysis, sol fraction, and differential thermal analysis of irradiated specimens are presented. (JAIF)

29920 EFFECTS OF HIGH ENERGY RADIATION ON THE ELECTRICAL PROPERTIES OF POLYMERS. Ukichi Shinohara (Nagoya Univ.), Masayuki Ieda, and Yonekazu Inagaki. Proc. Japan Conf. Radioisotopes, 4th, 364-7 (1961). (In Japanese)

The effects are studied of high-energy radiation on the electrical properties of polymers. The knowledge obtained through this study gives information on the application of high-energy radiation for various polymers to be used as electrical insulators. The effects of γ and pile radiation on the electrical properties of polyethylene and plasticized polyvinyl chloride are determined. (JAIF)

29921 SELECTIVITY IN RADIATION-INDUCED SCISSION OF POLYVINYL ALCOHOL (PVA). Yutaka Hirano and Ayao Amemiya (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 4th, 367-70(1961). (In Japanese)

PVA is fractured under the influence of ionizing radiation at room temperature in solid state, and the degree of polymerization of irradiated PVA decreases with radiation dose. Most of the main chain of usual PVA consists of two types of chemical bond—1.3 glycol type and 1.2 glycol type. It is found that a certain selectivity in radiation-induced scission of these types of bonds occurs in PVA. The experimental results show that, within the experimental error, only special types of bond can be fractured selectively. (T.F.H.)

29922 IRRADIATION EFFECTS ON POLYMER BLEND. Sanyo Hori, Shozo Iida, Hiroshi Sakami, and Toshiaki Adachi (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 370-3 (1961). (In Japanese)

The crosslinking and block or graft copolymerization by irradiation in polymer blends was discussed, with a view toward achieving homogeneous blending. Polymer blends of high- and low-density polyethylene, obtained by mechanical and chemical methods, were gamma-irradiated. The specific heat-temperature relationship and other characteristics of this system were measured. (T.F.H.)

29923 RADIATION EFFECT ON POLYMER BINARY SYSTEM. Fumio Kobayashi, Tatsuo Iwasaki, and Kosuke Tomita (Nippon Rayon Co., Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 373-7(1961). (In Japanese)

Radicals on adjacent polymer chains, formed by high-energy radiation, are capable of combining to give crosslinks. In the presence of a second, compatible polymer, the radical sites serve as junction points of crosslinking to give so-called "co-vernetzung." An attempt is made to produce co-vernetzung using γ and u-v rays. Polymethylmethacrylate—polyvinylacetate and nylon-6—polyvinylalcohol are selected. The latter is able to mix homogeneously using formic acid as a solvent (but in this case polyvinylalcohol converted into polyvinylformate). (T.F.H.)

29924 RADIATION-INDUCED CROSSLINKING OF EPOXY RESIN. Ken-ichi Shinohara and Tomomichi Kasamatsu (Japanese Assn. for Radiation Research on Polymers). Proc. Japan Conf. Radioisotopes, 4th, 377-80(1961). (In Japanese)

Epoxy resin has the 3-membered-ring epoxy group, which will spring open under slight provocation. A variety of compounds with active hydrogen, including amines, acids, phenols, alcohols, and thiols, is capable of opening the three-membered ring and forming larger molecules having a secondary hydroxyl group. This reaction may be produced thermally, but γ-rays from Co-60 can also be used. When triethylenetetramine, as an example of polyamines, is used, the gelation curve is obtained. Below 24°C, the gelation of epoxy resin is incomplete and the gel fraction attainable is not more than 0.75 in thermal reaction, but in the radiation reaction the gelation is almost complete and a gel fraction of over 0.90 is obtained. The activation energy is found to be 34.7 kcal/mol in both cases. In radiation reaction, the reaction velocity is found to be proportional to $I^{0.96}$, where I is the dose rate. When piperidine, as an example of the secondary monoamines, is used, the gelation curve is also obtained. In thermal reaction, it requires over 7 hrs at 110°C to complete the reaction, but under γ irradiation, 2 hrs at 50°C is found to be enough. At 19°C, γ rays do not complete the crosslinking of epoxy resin. The activation energy is found to be 23.3 kcal/mol. (JAIF)

29925 IRRADIATED POLYETHYLENE SHEATHED CABLE. Masao Watanabe, Shigeyuki Tanaka, and Shotaro Tada (Sumitomo Electric Industries, Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 380-3(1961). (In Japanese)

The suitability of irradiated polyethylene for use in electric wires and cables is judged. Electron irradiation caused little change in its dielectric constant and dissipation factor. Although the dielectric constant is scarcely affected by heat aging, the dissipation factor increases in proportion to irradiation dose. The electric properties of polyethylene are scarcely deteriorated by electron irradiation. (T.F.H.)

29926 IRRADIATION EFFECTS ON POLYPROPYLENE. Sanyo Hori, Shozo Iida, Hiroshi Sakami, and Toshiaki Adachi (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 383-6 (1961). (In Japanese)

The physical properties of γ-irradiated polypropene (PP) were discussed. The crystallization properties of PP differed with the polymerization conditions because of the difference of tacticity and stereo irregularity. The relation between radiation effects and these molecular structures, and the radiation effect on PP having different crystallinities and higher order structures varied by the condition of heat treatment, is discussed. As the physical properties of irradiated PP, elasticity, density, x-ray scattering, specific volume, and specific heat are measured. From these experiments concentration of end links, changes in degree of crystallinity, and melting point are determined. (T.F.H.)

29927 IRRADIATION EFFECTS ON POLYETHYLENE. Sanyo Hori, Shozo Iida, Hiroshi Sakami, and Toshiaki Adachi (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 386-90(1961). (In Japanese)

Crosslinking and decomposition are produced by the irradiation of polyethylene. The physical properties of irradiated polyethylene are studied. (T.F.H.)

29928 DISCOLORATION OF POLYVINYL CHLORIDE BY γ-RAY IRRADIATION. Tsunesaburo Asada (Osaka Univ.), Masaharu Kawanishi, and Kiyoshi Ishikawa. Proc. Japan Conf. Radioisotopes, 4th, 390-3(1961). (In Japanese)

Specimens of non-plasticized, rigid, and transparent polyvinyl chloride sheets in thicknesses ranging from 0.1 to 5.3 mm are irradiated to a dose of 1.4×10^6 r. Changes of optical density in relation to the time lapse are measured by a spectrophotometer. (T.F.H.)

29929 STUDY OF RADIATION-OXIDATION OF POLYMERS BY MEANS OF ESR AND IR SPECTROSCOPY. Shun-ichi Ohnishi, Shun-ichi Sugimoto, and Isamu Nitta (Japanese Assn. for Radiation Research on Polymers, Osaka). Proc. Japan Conf. Radioisotopes, 4th, 393-7 (1961). (In Japanese)

Radiation-oxidation of polyethylene (PE), polypropylene (PP), and polyvinyl chloride (PVC) is studied by means of ESR and IR spectroscopy. Several kinds of radicals are produced by irradiation, and by irradiation under suitable conditions a sample can be obtained in which a specified radical is rich. Samples are prepared in which certain radicals are rich, and changes after breaking vacuum are followed. The radicals are $-CH_2-\dot{C}H-CH_2-$ (FR_{VI}), $-CH_2-\dot{C}H-CH=CH-CH_2-$ (FR_{VII}), and $-CH_2-\dot{C}H-(-CH=CH-)_n-CH_2-$ (FR_I) in PE; $-CH_2-\dot{C}(CH_3)-CH_2-$ (FR_{VIII}), $-CH_2-\dot{C}(CH_3)_2$ (FR_{IX}), polyenyl radicals with shorter conjugation (FR_{ds}), and polyenyl radicals with longer conjugation (FR_l) in PP; and FR_{ds} and FR_l in PVC. Of the radicals, those that give the ESR asymmetric single spectrum of peroxide radical after introduction of air are of the alkenyl type, except for FR_{VIII} and FR_{IX} in PP. FR_{VI} in PE does not show this asymmetric spectrum. Oxygenation temperatures of the radicals are determined. (JAIF)

29930 ELECTRON SPIN RESONANCE SPECTRA AND CHANGE OF PHYSICAL STATE IN IRRADIATED POLYETHYLENE. Hisatsugu Kashiwabara and Ken-ichi Shinohara (Japanese Assn. for Radiation Research on Polymers, Tokyo). Proc. Japan Conf. Radioisotopes, 4th, 397-401(1961). (In Japanese)

By use of irradiation and ESR measurements at temperatures from 77 to 400°K, information on the nature of the ESR spectra of irradiated polyethylene was obtained. Up to the order of 10^6 rads of irradiation dose, two kinds of patterns are seen superposed in ESR spectrum obtained at room temperature—one a six-line pattern corresponding to alkyl type free radicals, and the other a seven-line pattern corresponding to alkyl type free radicals—separated from each other by the differences in decay rates of their respective patterns at room temperature. When the dose increases over 10^9 rads, the ESR spectrum of irradiated polyethylene becomes a single-line spectrum, which is considered to be the spectrum corresponding to the polyene type radicals. If the irradiation is carried out at 77°K and the spectrum is measured at the same temperature, a rather apparent six-line spectrum is observed, reflecting the dominant existence of free radicals of alkyl type. The six-line pattern decays rapidly, and a seven-line pattern is stable at room temperature. (T.F.H.)

29931 ON THE MECHANISM OF RADIOLYSIS OF AMINO ACIDS, PEPTIDES AND PROTEINS BY γ-RAYS. Hiroyuki Hatano (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 4th, 401-5(1961). (In Japanese)

Liberation of ammonia took place when aqueous solutions of amino acids, peptides, and proteins were irradiated with γ rays. Ammonia yield was not affected over a wide range of doses, while the yield increased with the concentration of the amino acid solution. α-amino groups were liberated more easily than β-amino groups, which were liberated more easily than γ-amino groups, in amino carboxylic acid solutions. Amino sulfonic acid was deaminated less readily than amino carboxylic acid. To the liberation of ammonia in γ-irradiated peptide and protein solutions, not only free amino groups but also peptide bonds were proved to contribute. α-keto acid was found to be produced from its parent amino acid by γ irradiation in oxygen-containing aqueous solutions. α-keto acids and 2,4-dinitrophenylhydrazones (DNPH) were characterized and determined spectrophotometrically after quantitative separations. Reaction yield of α-keto-glutamic acid obtained from glutamic acid was affected by irradiation conditions. The yield of decomposed α-alanine was identical stoichiometrically with that of liberated ammonia. Further decomposition of pyruvic acid by larger doses of γ rays was observed in aqueous solutions of alanine. When oxygen-containing solution of alanylvaline was irradiated with γ rays, pyruvic acid and α-ketoisovaleric acid, which were the corresponding α-keto acids to the constituent amino acid (alanine and valine) of the peptide, were produced in the irradiated solutions. The DNPH of pyruvic acid and of α-ketoisovaleric acid could be separated and determined quantitatively. (JAIF)

29932 γ-RADIATION-INDUCED CHANGE IN SUSCEPTIBILITY OF AMYLOSE WITH AMYLASES. Akemi Nishimura and Ken-ichi Takaoka (Ohtani Women's Junior Coll.). Proc. Japan Conf. Radioisotopes, 4th, 405-9(1961). (In Japanese)

The influence of irradiation on the susceptibility of amylose to the action of amylases is studied. Amylose is irradiated in solid state by a Co-60 source, receiving a total dose of 10^5 to 10^8 r at a dose rate of 6×10^4 r/hr in air at room temperature. (T.F.H.)

29933 RADIATION DAMAGE OF ORGANIC LINING ON SPENT FUEL STORAGE TANK. Iwao Iwata, Yasuhiko Iso, and Mamoru Ichinose (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 409-12(1961). (In Japanese)

A test was planned in order to find the most suitable lining material for the spent fuel storage tank in a reactor facility. Because the lining of the spent fuel storage tank makes contact with pure water under high γ-radiation exposure, the most desirable material would be stainless steel. Stainless steel would also be quite expensive, and cheaper materials, such as organic paint lining, might be considered. Organic paints were selected and their radiation damage was tested in pure water. Two types of lining, coating type and lining type reinforced with glass wool, were prepared for epoxy, polyester, and polyurethaneresin paints, while vinyl-chloride, phenol, and silicon resin paints were by only coating type. Each sample was irradiated up to a dose of 10 r in pure water (pH 6 to 7). Changes in physical properties (color, gloss, weight, hardness, flexibility, and impact resistance) and in decontamination factor are followed. (JAIF)

29934 RECENT PROGRESS IN APPLICATIONS OF HIGH-INTENSITY RADIATION FACILITIES AND SOURCES. Paul C. Aebersold (Office of Isotopes Development, AEC). Proc. Japan Conf. Radioisotopes, 4th, 413-23(1961). (In English)

Although the U. S. AEC radiation development program has been in existence only a few years, it has initiated a

variety of research projects with promising potential for practical applications. Among these have been the radiation synthesis of high-purity silicon for possible use in semi-conductor materials and the radiation halogenation and cyanogenation of organic compounds. A variety of studies has been expanding knowledge of radiation graft polymerization and of radiation-induced gelation of monomer-polymer mixtures. Other investigations have ranged from the more rapid sedimentation of sewage exposed to ionizing radiation to the improvement of textiles through polymerization of absorbed monomers. Basic to these developments have been investigations on the reaction mechanisms and intermediate ion-molecule complexes formed in irradiated materials. (T.F.H.)

29935 STUDIES OF PRIMARY RADIATION PROCESSES USING THE COINCIDENCE MASS SPECTROMETER. William H. Johnston, Austin L. Wahrhaftig, Marvin L. Vestal, Manfred Krause, and Fred Lampe (William H. Johnston Lab., USA). Proc. Japan Conf. Radioisotopes, 4th, 434-45(1961). (In English)

The development of the Coincidence Mass Spectrometer (CMS), and its application to studies of primary radiation processes, is reviewed. The construction, operation, and unique measurements of the CMS, and the results of several studies of primary radiation processes, are presented. These studies are applied to analyses of several potentially important radiation systems. In operation the CMS ionizes an individual molecule by electron or photon collision. The secondary electron is collected immediately (less than 10 nanoseconds) and the corresponding ion is accelerated and allowed to drift. The differential arrival time of the electron and ion at their detectors defines the charge-to-mass ratio of the ion. Three data handling systems for taking mass spectra are described. The advantages of this instrument include high sensitivity, unique information on multiplicity of ion-charge, and convenience in studies of very rapid metastable decompositions. (T.F.H.)

29936 RADIATION SYNTHESIS INVOLVING HALOGEN COMPOUNDS. P. Y. Feng, W. A. Glasson, L. Mamula, K. Schmude, and S. Soffer (Armour Research Foundation, USA). Proc. Japan Conf. Radioisotopes, 4th, 445-50(1961). (In English)

A series of experiments involving organic halogen compounds is carried out for the primary purpose of studying the use of radiation in the syntheses of organic fluorine compounds. The organic systems studied include CF_4 + C_6H_6, CF_4 + $C_6H_5NO_2$, CF_4 + $C_6H_5CH_3$, SiF_4 + $C_6H_5CH_3$, SF_6 + $C_6H_5CH_3$, and BF_3 + $C_6H_5CH_3$, as well as mixtures containing other halogens such as CCl_4 + $C_6H_5CH_3$, CBr_4 + $C_6H_5CH_3$, etc. As a rule, the radiolysis of the fluorine-containing mixtures produces with varying degrees of efficiency, fluorinated products, which retain the aromaticity of the benzene nucleus. In addition, both the nature of the products produced, and considerations based on the known properties of fluorine compounds, suggest strongly the possibility of mechanisms involving ionic reaction intermediates for the fluorination reaction. (T.F.H.)

29937 CRYSTALLINE POLYMERS BY RADIATION-INDUCED POLYMERIZATION OF RING COMPOUNDS. Seizo Okamura, Koichiro Hayashi, Yasuhisa Kitanishi, Haruhiko Watanabe, and Masanobu Nishii (Japanese Assn. for Radiation Research on Polymers, Osaka). Proc. Japan Conf. Radioisotopes, 4th, 450-6(1961). (In English)

It was found that ring compounds such as trioxane, β-propiolactone, diketene, 3,3-bischloromethylcycloxabutane, and cyanuric chloride can be polymerized by ionizing radiation in the solid state. Moreover, when these monomers are irradiated in large crystalline state, the polymers obtained have higher melting point and better orientation than those obtained from sudden-cooled microcrystalline monomers. The polymers from large crystalline monomers have an outward appearance of large crystals as if order and orientation of monomers have been transferred directly to the polymers. X-ray diffraction photographs are made of the polymers after they are separated from residual monomers and dried. In all cases, polymers from large crystalline monomers have greater orientation as compared to polymers from sudden-cooled monomers. It is concluded that the structure of the monomer lattice has a great effect upon the propagation of solid-state polymerization. (JAIF)

29938 ON THE MECHANISM OF THE RADIATION-INDUCED POLYMERIZATION OF α-METHYLSTYRENE. Kozo Hirota (Osaka Univ.) and Fukuo Takemura. Proc. Japan Conf. Radioisotopes, 4th, 472-4(1961). (In Japanese)

Though α-methylstyrene (αMS) was hardly polymerizable by use of peroxide initiators, it could be polymerized with γ rays at room temperature. The mechanism for this polymerization was studied by a copolymerization experiment. A mixture (1 : 1) of αMS and MMA (methylmethacrylate) was irradiated with γ rays at room temperature. The infrared spectrum of the polymer thus obtained contained the bonds of both carbonyl and phenyl groups, suggesting it to be a copolymer. Moreover, it was quite similar to the spectrum of the product radically copolymerized from the mixture of αMS and MMA with azo-bis-isobutylnitrile. Since MMA is hardly polymerizable by a cationic catalyst, this result would support a radical mechanism of αMS polymerization. (T.F.H.)

29939 BEHAVIOR OF VARIOUS CELLULOSES AT GRAFT COPOLYMERIZATION BY IRRADIATION. Ichiro Sakurada, Toshio Okada, Fujiko Kimura, and Shigeyuki Hatakeyama (Japanese Assn. for Radiation Research on Polymers, Osaka). Proc. Japan Conf. Radioisotopes, 4th, 474-81(1961). (In English)

Cellulose exhibits various behavior in chemical reactions when its micro- and submicro-structure are different. Graft copolymerization of styrene on the various celluloses is described. Four kinds of cellulose fibers are employed, i.e., regular rayon staple fiber, high strength staple fiber, polynosic fiber, and cotton. Simultaneous and pre-irradiation techniques of high-energy radiation are applied for the grafting. (T.F.H.)

29940 PRODUCTION OF RADIOISOTOPES BY JRR-1 REACTOR. I. TEST PRODUCTION OF P-32. Kenjiro Kimura, Nagao Shibata, Tsutomu Mochizuki, Hiroshi Amano, Haruto Nakamura, Hiroshi Baba, and Mutsumasa Arai (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 485-7(1961). (In Japanese)

P-32 was produced by the (n,p) reaction on S-32 by irradiating elementary sulfur target in JRR-1 reactor. (JAIF)

29941 PRODUCTION OF RADIOISOTOPES BY JRR-1 REACTOR. II. TEST PRODUCTION OF I-131. Kenjiro Kimura (Japan Atomic Energy Research Inst.), Nagao Shibata, Tsutomu Mochizuki, Eiji Shikata, Norio Masaki, Yoshio Yoshimura, and Kentaro Hata. Proc. Japan Conf. Radioisotopes, 4th, 488-91(1961). (In Japanese)

I-131 was produced in JRR-1 reactor by irradiation of telluric acid according to the reaction $Te^{130}(n,\gamma)Te^{131} \xrightarrow{\beta^-}$ I-131. For mass production of I-131, several problems,

such as choice of target material, processing after irradiation, construction of apparatus, and properties of the products, were tested in JRR-1. (T.F.H.)

29942 PRODUCTION OF RADIOISOTOPES BY JRR-1 REACTOR. III. TEST PRODUCTION OF S-35. Kenjiro Kimura, Bagai Shibata, Tsutomu Mochizuki, Hiroshi Amano, Eiji Shikata, Taro Ito, and Terutomi Moki (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 491-5(1961). (In Japanese)

S-35 was produced in JRR-1 reactor, and in order to confirm the basis for the production of this nuclide, several experiments were carried out. As a target material for the production of S-35 with (n,p) reaction on Cl-35, chlorine compounds such as ammonium chloride, potassium chloride, and benzene hexachloride (B.H.C.) were tested. (T.F.H.)

29943 PRODUCTION OF RADIOISOTOPES BY JRR-1 REACTOR. IV. TEST PRODUCTION OF Na-24, K-42, Au-198, AND OTHERS. Kenjiro Kimura (Japan Atomic Energy Research Inst.), Tsutomu Mochizuki, Hiroshi Amano, Taro Ito, Tomonori Takeda, Katsuhiro Tachikawa, and Tetsuki Yokoshima. Proc. Japan Conf. Radioisotopes, 4th, 496-9(1961). (In Japanese)

The radioisotopes Na-24, K-42, Au-198, and others were produced on a trial basis in reactor JRR-1. Sodium carbonate, potassium carbonate, and gold wire were used as target materials. Irradiations were carried out for 2 or 15 hours intermittently in JRR-1 in a thermal flux of about 2 to 3×10^{11} n/cm^2/sec. The target materials are enclosed in the polyethylene sheet and packed into the screw type capsules, made of 2S aluminum. As for chemical processing, the irradiated target materials are only dissolved in appointed concentrated hydrochloric acid in case of Na-24 and K-42, and in aqua regia in case of Au-198. The apparatus was simple, consisting of a glass dissolver, sampling pipettes, and solenoid valves or Teflon stopcocks, connected together by glass tubing. The production was carried out several times, the maximum activities of products were 50, 30, and 100 mC for Na-24, K-42, and Au-198, respectively, and their specific activity was ~25 mC per g of Na, ~2 mC per g of K, and ~200 mC per g of Au. (T.F.H.)

29944 PRODUCTION OF RADIOISOTOPES BY JRR-1 REACTOR. V. ON THE STUDY OF THE PREPARATION OF SOME RADIOISOTOPES OF A HIGH SPECIFIC ACTIVITY BY THE SZILARD-CHALMERS REACTION. Kanjiro Kimura, Nagao Shibata, Kenji Yoshihara, Kichizo Tanaka, and Haruto Nakamura (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 499-501(1961). (In Japanese)

The Szilard-Chalmers technique was adopted to produce Cr-51, Fe-55, Fe-59, and Cu-64 in a high specific activity, and separation processes were studied with different target materials of oxyacid salts and metal complexes. (T.F.H.)

29945 PRODUCTION OF RADIOISOTOPES BY JRR-1 REACTOR. VI. THE STUDY OF PREPARATION OF SPECIAL RADIOISOTOPES. Kenjiro Kimura, Nagao Shibata, Eiji Shikata, Kichizo Tanaka, and Chizuko Shikata (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 502-5(1961). (In Japanese)

Some radioisotopes are produced by JRR-1 Reactor at request. The production of F-18, high-specific-activity Na-24, Co-58, and As-77 is reported. (T.F.H.)

29946 RADIOISOTOPE PRODUCTION TECHNIQUES AT THE RESEARCH ESTABLISHMENT OF THE AUSTRALIAN ATOMIC ENERGY COMMISSION. G. R. Newman and J. N. Gregory. Proc. Japan Conf. Radioisotopes, 4th, 506-18(1961). (In English)

An account is given of the planning of facilities in the reactor HIFAR for producing an extensive range of isotopes. Various classes of irradiation and handling equipment are described. The operations of equipment are mentioned. (T.F.H.)

29947 PRODUCTION OF RADIOISOTOPES OF JRR-1 REACTOR. VII. CHEMICAL ASSAY. Kenjiro Kimura, Nagao Shibata, Tamaki Watanabe, and Kyohei Suzuki (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 519-22(1961). (In Japanese)

The method of chemical assay of radioisotopes produced in JRR-1 reactor was studied. The items of the assay included evaluation of specific activities, determination of radiochemical impurities, estimation of non-radioactive impurities, test for total solid and non-volatile materials in the products, etc. (JAIF)

29948 PRODUCTION OF RADIOISOTOPES BY JRR-1 REACTOR. VIII. ASSAY OF RADIOACTIVITY. Kenjiro Kimura, Nagao Shibata, and Tamaki Watanabe (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 522-6(1961). (In Japanese)

In supplying radioisotopes produced in Japan Atomic Energy Research Institute, it is necessary to measure the specific activity (mC/mg), concentration (mC/ml), and total activity of each product. These are obtained from absolute values of radioactivity. Two methods of measurement—absolute and relative—of radioactivity are described. (JAIF)

29949 THE PRODUCTION OF IODINE-125 AND OTHER RECENT RADIOISOTOPE DEVELOPMENTS AT OAK RIDGE NATIONAL LABORATORY. E. E. Beauchamp, P. S. Baker, L. O. Love, and E. Lamb (Oak Ridge National Lab., Tenn.). Proc. Japan Conf. Radioisotopes, 4th, 527-31(1961). (In English)

Procedures are discussed for the production of iodine-125 and other radioisotopes with potential application possibilities. Although the radioisotopes of concern can be produced by cyclotrons, reactor production holds promise to make them available at low cost, which should result in a greater potential for applications. (JAIF)

29950 METHOD OF THE CHOICE OF "COOLING TIME" TO REDUCE INTERFERING ACTIVITY IN NEUTRON ACTIVATION ANALYSIS. Fumio Aoki and Minoru Okada (Government Chemical Industrial Research Inst., Tokyo). Proc. Japan Conf. Radioisotopes, 4th, 532-8 (1961). (In Japanese)

To get a proper choice of "cooling time" (θ) to reduce an interfering activity in non-destructive activation analysis using thermal-neutron irradiation and γ-ray spectrometry, the relation between signal-to-noise ratio and θ is studied theoretically for two cases: that in which the half life of the interfering activity cannot be foreseen; and that in which an interfering nuclide can be foreseen. A desired γ ray emitted from a neutron-induced nuclide is likened to a signal, and the interfering γ ray to a noise. (JAIF)

29951 ALPHA PARTICLES FROM THE INTERACTION OF 14-Mev NEUTRONS WITH ARSENIC. O. N. Kauk and B. D. Nag (Saha Inst. of Nuclear Physics, India). Proc. Japan Conf. Radioisotopes, 4th, 542-5(1961). (In English)

Energy and angular distribution of alpha particles from

$As^{75}(n,\alpha)Ga^{72}$ are studied by the emulsion technique. The area under the energy distribution shows that the number of alpha particles emitted below the Coulomb barrier is more than is expected from the statistical theory. Angular distribution about the center of mass system is roughly symmetrical about 90°, and concave upwards. Relative level density plotted from the energy distribution fits a straight line, except on the low-energy side, and corresponds to a nuclear temperature of 0.9 Mev. The total cross section is estimated to be 29 mb ± 10%. The results are discussed in the light of compound nucleus theory. (JAIF)

29952 SYNTHESES OF RI LABELED ORGANIC COMPOUNDS BY IRRADIATION. THE NEUTRON IRRADIATION OF CHLOROBENZOIC ACIDS. Ko Taki and Yasushi Hishiki (Inst. of Physical and Chemical Research). Proc. Japan Conf. Radioisotopes, 4th, 546-9(1961). (In Japanese)

The recoil labeling method is applicable where conventional methods of incorporation of a radioactive isotope, such as synthesis or exchange, prove to be difficult or impossible. The recoil method holds promise in the labeling of complex natural products and in preparing large quantities of low-labeled material. There is some hope that some types of molecules with extremely high specific activity may also be prepared by recoil labeling. C-14, S-35, and Cl-36 are formed by the N-14 (n,p) C-14, Cl-35 (n,p) S-35, and Cl-35 (n,γ) Cl-36 reactions. S-35 atoms are produced at the JRR-1 pile through the reaction of thermal neutrons in the Cl-35 (n,p) S-35 process. α, β-chloronaphthalene, o-, m-, p-chloronitrobenzene, and o-, m-, p-chlorobenzoic acids are irradiated in the JRR-1 pile at an approximate neutron flux of 10^{11}n/cm²/sec for 40 to 60 hours. After irradiation, one month was allowed for decay of short-lived activities arising from impurities in the irradiated compounds. o-, m-, p-dinitrodiphenyldisulfides are isolated from irradiated o-, m-, p-chloronitrobenzene by carrier technique. And o-, m-, p-dithiodibenzoic acids are isolated from irradiated o-, m-, p-chlorobenzoic acids and, mixture of benzoic acid and p-dichlorobenzene, by above method. The purification of these added carrier compounds is carried out by recrystallization and chromatography. These pure isolated carrier compounds are oxidized by the Schöniger method and their radioactivity measured as infinite thickness of barium sulfate. Radiochemical yields of o-, m-, p-compounds are tabulated. (JAIF)

29953 THE PRODUCTION OF LONG-LIVED ISOMERS BY THE USE OF THE ELECTRON LINEAR ACCELERATOR AND ITS APPLICATION. Tokishi Kaminishi and Chiyo Kojima (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 549-53(1961). (In Japanese)

A number of natural elements is irradiated with electrons or converted photons using a 6-Mev electron linear accelerator. In this case the type of reaction is (γ,γ), in which nuclides absorb x rays resonantly and come to isomers. A water-cooled lead target is used as an x-ray converter. After the irradiation, the isomeric nuclide is determined by measuring its half life and the energy spectrum of the gamma transitions. The production of the following isomers is confirmed: Sr-87m, Y-89m, Rh-103m, Ag-107m + Ag-109m, Cd-111m, In-113m, In-115m, Sn-117m, Ba-135m, Ba-137m, Hf-179m, Pt-195m, Au-197m, and Hg-199m. The half lives range between the 7 seconds and 14 days. (JAIF)

29954 STUDY ON THE METALLIC IMPURITIES IN PURE ALUMINUM BY MEANS OF ACTIVATION METHOD. Masatoshi Kobayashi and Teruko Mihara (Tokyo Metropolitan Isotope Center). Proc. Japan Conf. Radioisotopes, 4th, 554-7(1961). (In Japanese)

Activation analysis of the impurities in aluminum of various grades is tried, followed by the study of the behavior of some impurities such as antimony, scandium, gallium, and samarium. The segregation of some of these minor elements and their diffusion behavior are studied by autoradiographic techniques for the metallic samples prepared by the addition of these elements and irradiated in the thermal neutron flux of 10^{12} n/cm²/sec. (T.F.H.)

29955 ELECTROCHROMATOGRAPHIC AND NEUTRON-ACTIVATION PROCEDURES FOR THE SEPARATION AND ESTIMATION OF THE ALKALI METAL CATIONS. Harold H. Strain (Argonne National Lab., Ill.). Proc. Japan Conf. Radioisotopes, 4th, 558-61(1961). (In English)

Differential electrical migration in electrolytic solutions stabilized in soft paper provides a convenient method for the separation of the alkali metal cations from virtually all the other cations. Under suitable conditions the differential migration also serves to separate the alkali metal ions from one another. This technique is effective with the smallest quantities of the ions that can be detected by the most sensitive tests. The background electrolyte and the solvent determine the effectiveness of the separations. With certain complex-forming electrolytes such as citrate in water, the alkali metal cations are separated from all the complexed polyvalent cations. With other complex-forming reagents such as ammonia-triacetic acid (nitrilotriacetic acid) plus cyanide, the alkali metal cations are separated from the polyvalent cations and also from the univalent cations of silver and thallium. In aqueous solutions, lithium, sodium, and potassium ions are readily separated from one another as well as from various complexed species. Potassium, rubidium, and cesium ions are not separated from one another. In nitromethane solution, by contrast, all the alkali metal ions are separated from one another. With radioactive species, the separated ions may be located and estimated in the moist paper. The lithium is not sufficiently radioactive to permit its location or estimation by its activity. It may be located by flame photometry in extracts of the migration system. Sodium and potassium salts are brought to sufficient activity by irradiation with thermal neutrons at a flux of 1×10^{12} n/cm²/sec for about two days before migration. Rubidium and cesium require activation at much higher fluxes (1×10^{14}) for longer periods (about 7 days). Active cesium as it occurs in fission products is readily separated from the active species of various other elements as well as from the other alkali metal cations. It may also be estimated after decay of activated sodium, potassium, and rubidium ions produced by activation of mixtures of these elements. (JAIF)

29956 APPLICATION OF COMPTON SCATTERING TO VARIABLE ENERGY γ-RAY SOURCE. Tokishi Kaminishi (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 562-6(1961). (In Japanese)

When a photon undergoes Compton scattering, the energy E (Mev) of the scattered photon is determined by the incident energy E_0 (Mev) and by the scattering angle θ. Therefore, a monochromatic γ-ray source, in which the secondary γ energy varies from $E_0/(1 + 2E_0/0.511)$ to E_0 with θ, may be constructed. The intensities of the scattered-rays can be calculated by the Klein-Nishina formula. There is a

limit in the increase of the scattered rays by the use of a larger scatterer. The limit is attributed to the following: self-absorption of both the incident and the scattered rays by the large scatterer itself; multi-scattering in the scatterer; and energy shift by localization of the scattering. In addition, other kinds of radiation besides Compton-scattered rays should be considered, that is, coherent scattering radiation, fluorescent x-rays, and annihilation radiation. Experiments are made to obtain monochromatic rays in this way. (JAIF)

29957 FLUORESCENT X-RAY ANALYSIS USING RADIOISOTOPES. Shigemasa Enomoto and Chizuo Mori (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 566-70(1961). (In Japanese)

Fluorescent x-ray analysis using a radioactive β source or a β-excited x-ray source is applied to the measurement of coating thickness, and to the analysis of binary alloys. The K x rays from an element, produced by the irradiation with the sources, are detected by counters, and discriminated by a pulse height analyzer or a filter. (T.F.H.)

29958 DETERMINATION OF MERCURY IN RICE BY ISOTOPE DILUTION ANALYSIS. Nobuo Suzuki (Tohoku Univ.). Proc. Japan Conf. Radioisotopes, 4th, 570-4(1961). (In Japanese)

In order to determine whether the distribution of mercury and use of mercurials in agriculture result in accumulation of mercury in foodstuffs, a study is made, by use of Hg-203, of the procedures of separation of mercury, and of procedures of determination of Hg by the quantitative isotope dilution analysis. (T.F.H.)

29959 SOLVENT EXTRACTION BEHAVIOR OF INORGANIC IONS. Tomitaro Ishimori, Kan Kimura, Eiko Nakamura, et al. (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 574-81(1961). (In Japanese and English)

Solvent extraction is useful in such processes as separation, isolation, purification, and identification of elements. It appears, therefore, to be convenient to have data for all chemical elements in many solvent extraction systems. From the list of solvent extraction behavior of elements, it would be possible to find easily a system in which a desired separation is possible. The behavior of sixty chemical elements from sodium to curium is surveyed radiochemically to get this kind of list. Several solvent extraction systems are surveyed. (T.F.H.)

29960 PREPARATION OF ACTINIDE ELEMENTS ON TRACER SCALE. Tomitaro Ishimori, Kan Kimura, Eiko Nakamura, et al. (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 581-7(1961). (In Japanese)

A summary is given of methods employed for tracer production of Th^{234}, Pa^{233}, U^{233}, Np^{237}, Np^{239}, and Pu^{239}. (T.F.H.)

29961 PREPARATION OF CARRIER-FREE Th-234 (UX_1) FROM URANYL NITRATE BY ANION EXCHANGE IN ALCOHOL NITRIC ACID MIXED SOLUTION. Jun Akaishi (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 587-90(1961). (In Japanese)

Procedures are studied for the preparation of carrier-free Th-234 from uranyl nitrate with anion exchange resin-7.5N nitric acid solution and anion exchange resin-alcohol nitric acid mixed solution systems. Good results are obtained, especially by the latter system, with regard to radiochemical purity and yield. The yield of Th-234 and its daughter nuclide Pa-234 from 1 g of uranyl nitrate crystal is about 1.1×10^5 dpm by the former procedure and 4.6×10^5 dpm by the latter procedure. The radiochemical impurity is not observed by the β and γ energy measurement. (T.F.H.)

29962 COLUMN-CHROMATOGRAPHIC SEPARATION OF HALOGEN COMPOUNDS WITH THE ABSORPTION OF SOFT γ-RAYS, β-RAY-EXCITED X-RAYS AND K-CAPTURE X-RAYS. Tadashi Nozaki (Nippon Telegraph and Telephone Corp.). Proc. Japan Conf. Radioisotopes, 4th, 590-3(1961). (In Japanese)

A mixture of 100g of biphenyl and 100g of iodine in acetic acid was caused to react by adding nitric acid. After the nitro-compound was reduced with Sn(II) chloride into amine and removed with warm water, the iodo-compound was digested with 3 l of petroleum benzine, and the insoluble solid (almost pure 4,4-diiodobiphenyl) filtered off. The filtrate was poured into a column containing alumina. A collimated beam of characteristic x rays of mercury was caused to pass along a diameter of the column and to enter the head of a scintillation counter with a single channel analyzer, only the region of the photo-peak being counter. The iodine concentration at a desired location in the column was determined by moving the column. Two adsorption zones were observed; for the passage of the 100ml of the solution, the head of the first zone migrated at a rate of 1.8cm, (4-iodobiphenyl), while that of the second 0.8cm (4,4'-diiodobiphenyl). By the use of this information, 90g of 4-iodobiphenyl and 55g of 4,4'-diiodobiphenyl were easily obtained in pure state. Quaterphenyl was synthesized from three kinds of 4-iodobiphenyl; prepared by this method; prepared from commercial 4-aminobiphenyl; and containing a small quantity of 4,4'-diiodobiphenyl added intentionally. The yield of the condensation, purity (neutron activation analysis of iodine), and the scintillation efficiency (pulse-height distribution of the output pulse of photomultiplier) of the product were determined for each lot. (JAIF)

29963 EXPERIMENTS ON GASEOUS ISOTOPE LAMP. Takuya Hata, Kenzo Awazu, and Masahiro Morikawa (Mitsubishi Electric Mfg. Co., Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 599-603(1961). (In Japanese)

The essential part of the lamp is a glass bulb (lamp bulb) coated with phosphor film on the inner surface, and filled with radioactive gas (Kr^{85} or T). Advantages of these lamps are: no necessity for external power; and long life. The experimental bulb is made from non-browning glass, and its volume is about 3 cm^3. From a standpoint of luminosity factor, green light emissive phosphors are selected. ZnS:Cu is found most suitable because it shows no appreciable depreciation within experimental error against Co-60 γ irradiation. Moreover, it has a high luminosity factor and quantum efficiency for electron. The relation between the brightness and the amount of radioactive gas is examined. Filling pressure of gas is varied up to 4 atm, and luminosity is measured intermittently at a fixed distance from the bulb. At about three atm, illumination or brightness saturates entirely. (T.F.H.)

29964 A STUDY ON RADIOACTIVE SELF-LUMINOUS COMPOUNDS. I. LUMINESCENCE EFFICIENCY OF RADIOACTIVE SELF-LUMINOUS COMPOUNDS. Ryoichiro Huzimura, Yasuro Ato, and Masahiro Oishi (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 604-7(1961). (In Japanese)

The luminescence efficiency of radioactive self-luminous compounds is studied. Luminescence is obtained by the direct mixing of a radioisotope in a phosphor or by the external irradiation of a phosphor with β rays. In a mixed sample with constant specific activity, the leakage dose of β rays and the light intensity increase simultaneously with the thickness and begin to saturate at about 100 mg/cm^2. The relative luminescence efficiency, i.e., the ratio of light intensity to β intensity, decreases slowly with the concentration of the carrier isotope and/or with the specific activity. The β energy dependence with P-32, S-35, Ca-45, and Sr-90–Y-90 shows that the lower exciting energy induces the higher efficiency. Effects of the composition or the structure of the phosphors are shown. The luminescence induced by irradiation with ultraviolet light is also presented. The phosphors of silicate and tungstate type are luminous by β-ray excitation but not by uv light. Among the phosphors of zinc sulfide type, those fired at relatively low temperatures or in H_2S gas are poor materials for both the excitations. (T.F.H.)

29965 A STUDY ON RADIOACTIVE SELF-LUMINOUS COMPOUNDS. II. ON THE APPLICATION OF RADIOACTIVE SELF-LUMINOUS COMPOUNDS. Yasuro Ato, Ryoichiro Huzimura, and Masahiro Oishi (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 4th, 607-11(1961). (In Japanese)

The temperature dependence of the light intensity and the enhancement of the electroluminescence may be used as an application of radioactive self-luminous compounds. However, one of the limitations for this application is the deterioration of the materials. These problems are studied. The materials are phosphors of powder form of zinc sulfide or zinc silicate type and about 50 μC of radioactive isotopes such as Sr-90–Y-90 in carbonates mixed in 300 mg of these materials. The light intensity vs. the operating temperature in the first temperature rising course of each sample is shown. It is concluded that phosphors of t^{-n} decay type have strong temperature dependence and those of $e^{-\lambda t}$ decay type less temperature dependence, similar to the case of photoluminescence. The temperature dependence of photoluminescence is used to measure temperature. The use of a radioactive self-luminous compound for the detection of temperature is profitable because no external exciting system is necessary. The deterioration of light intensity by radiation damage in the compounds also exists. (JAIF)

29966 IRRADIATION EFFECT OF γ-RAY ON CdS CRYSTAL. Tsunesaburo Asada (Osaka Univ.), Masaharu Kawanishi, Hideo Ito, and Tadaoki Yamashita. Proc. Japan Conf. Radioisotopes, 4th, 611-14(1961). (In Japanese)

A CdS single crystal made by the sublimation method is used as a specimen to measure its various characteristics in the γ-ray field. CdS has many defects and its photoconductivity phenomena are complicated. The photoconductivity, its temperature dependence, radiation damage, and response time are reported for dose rates from 1 to 10^3 r/min. In case of illumination with visible light, the induced photoconductivity of CdS increases in proportion to the intensity of light up to 10^3 lux while over this intensity it nearly increases in proportion with the one-half power of light intensity. On the other hand, in case of irradiation with soft x rays or γ rays there is a satisfactory proportional relation between dose rate and induced photoconductivity in the range from 1 to 10^3 r/min. Under a constant irradiation of γ rays the photoconductivity slightly increases as the temperature rises up to about 50°C, while over 60°C the sensitivity deteriorates. The higher the dose rate, the more the temperature coefficient of photoconductivity increases. The change of photoconductivity caused by high irradiation dose is shown. The time constant with a crystal of low density of trapping centers is about several seconds for the range from 1 to 10 r/min, and shortens for the higher dose rate. (JAIF)

29967 RADIATION EFFECTS ON IONIC CRYSTALS. Noriaki Ito, Touichi Okada, Kazuyuki Akasaka, and Tokuo Suita (Osaka Univ.). Proc. Japan Conf. Radioisotopes, 4th, 615-17(1961). (In Japanese)

The effect of Co-60 γ irradiation on KCl and NaCl crystals is studied through the changes in optical absorption, thermo-luminescence, mechanical properties, and thermal recovery. (T.F.H.)

29968 EFFECTS OF Co γ RAYS ON ROCHELLE SALT. Tunnesaburo Asada (Osaka Univ.), Yoshitake Kimura, Keiichi Saheki, T. Akita, and Yuichi Mori. Proc. Japan Conf. Radioisotopes, 4th, 617-21(1961). (In Japanese)

When single crystals of Rochelle salt are irradiated by Co-60 γ rays, changes occur. The ferroelectric hysteresis loops change from the normal curves to the double hysteresis loops. "Sudare" increases in number. Etch pits increase in number. The color of the crystals alters to yellow, and the spectroscopic absorption curve changes. To examine the mutual relations of these changes, experiments are performed. (JAIF)

29969 ANNEALING OF γ-RAY DAMAGE IN GERMANIUM AND SILICON SINGLE CRYSTALS. Tsunesaburo Asada (Osaka Univ.), Haruo Saito, Masayoshi Iwasaki, Mitsuji Hirata, Takehumi Horiuchi, and S. Oka. Proc. Japan Conf. Radioisotopes, 4th, 625-7(1961). (In Japanese)

Annealing of germanium single crystals irradiated by γ rays from Co-60 at 0 to 55°C is studied. The conductivity change observed may be attributable to the preferential annealing of interstitial atoms. The conductance curves are analyzed into three stages. From the analysis of these curves, the activation energy for direct recombination of vacancy interstitial pairs, that for the diffusion of interstitial atoms, and that for the diffusion of vacancies is determined to be 0.76, 0.74, and 1.25 ev, respectively. (T.F.H.)

29970 ANOMALIES IN COUNTING RATE OF SOLID THIN FILM OF LAURIC ACID AND ITS FILM STRUCTURE. Kazuo Tajima, Tsunetaka Sasaki, and Mitsuo Muramatsu (Tokyo Metropolitan Univ.). Proc. Japan Conf. Radioisotopes, 4th, 631-3(1961). (In Japanese)

It is found that the counting rate of a solid thin film of tritiated lauric acid deposited from benzene solution decreases linearly with time, shows a break point at the end of ten days after the preparation of the film, and then decreases along another straight line. The slope of the former straight line is steeper than the latter, but they both are much less steep than are expected from the natural radioactive decay of tritium. These two slopes together with the data of the appearance of the break point are largely independent of the amount of the substance taken, provided that the amount is not large. The diagram as a whole can be reproduced from the film even after the appearance of the second straight line, if the film is renewed by dissolving it with benzene with subsequent evaporation, This result excludes the possibility of the existence of chemical or radiochemical impurities for the explanation. The measurement of the decrease in weight of the film substance by evaporation shows a simi-

lar diagram with a break point as in the case of radioactivity. It is conjectured that the anomalies observed are caused by the evaporation of the film, and that the break point occurring after ten days may be explained by the fact that the film consists of two portions, namely a thin film of uniform and constant thickness independent of the amount of the substance taken, and relatively large clusters projecting above the uniform thin film. (JAIF)

29971 JOSHI EFFECT IN COUNTERS UNDER VISIBLE AND GAMMA RADIATION. H. J. Arnikar (Banaras Hindu Univ., India). Proc. Japan Conf. Radioisotopes, 4th, 634-40(1961). (In English)

The need for shielding radiation counters from external light is recognized. A comparison of the experimental results on the photosensitivity of counters with those on the Joshi effect (an almost instantaneous and reversible photovariation, $\pm\Delta i$, of the discharge current i), reveals a marked similarity of the two phenomena. The use of a count-rate meter or a scaler is found to be adapted for studying the Joshi effect. Results for Δi in tubes of varying design, and charged with air, H_2, and I_2 vapor are presented, for irradiation both in the visible and gamma regions. Results on the variation of Δi with potential (V) and irradiation intensity (I) reveal that $\pm\Delta i$ is restricted to low values of V and I, beyond which there is a reversible inversion, $\pm\Delta i \rightleftharpoons -\Delta i$. (JAIF)

29972 THE EFFECTS OF SURFACE MATERIALS ON THE BACKSCATTERING OF γ- AND X-RAYS. Koji Odan (Kansai Paint Co., Ltd.), Masao Kato, and Otomaru Sato. Proc. Japan Conf. Radioisotopes, 4th, 645-8(1961). (In Japanese)

Incident γ and x rays are absorbed by shielding materials, or transmitted and partly scattered backward. The backscattered γ and x rays are influenced by the nature of the materials, especially of the surface materials. The relations are studied between the backscatter and the nature of the surface materials using γ rays of Cs-137 and x rays of 70 kev energy. (JAIF)

29973 GAMMA-RAY PENETRATION STUDIES FOR SEVERAL MATERIALS. I. MEASUREMENTS OF DOSE BUILDUP FACTORS. Shunichi Miyasaka (Japan Atomic Energy Research Inst.), Yutaka Furuta, Akira Tsuruo, Kozo Tamura, and Yoshihiko Kanemori. Proc. Japan Conf. Radioisotopes, 4th, 649-53(1961). (In Japanese)

One of the most important data for shielding calculation of gamma rays is the buildup factor. The dose buildup factors of water, aluminum, iron, and lead for parallel beams of Co-60 gamma rays are determined experimentally. (T.F.H.)

29974 ON THE PROBLEM TO SECURE THE SAFETY OF Co-60 SOURCE CAPSULES FROM LEAKAGE OF RADIOACTIVE MATERIALS. Akira Ohno (Japan Radioisotopes Assn.). Proc. Japan Conf. Radioisotopes, 4th, 654-7(1961). (In Japanese)

To secure the safety of Co-60 capsules from leakage of radioactive materials, the Japan Radioisotope Association organized a committee to examine and improve Co-60 capsules. Capsules are designed, made of stainless steel and consist of inner and outer capsules sealed with argon welding. Specifications, inspections, and testing are outlined. (JAIF)

29975 A DESIGN OF COBALT 60-RADIATION CAVE WITH LABYRINTH-TYPE ENTRANCE. Masao Kadonaga (Nippon Telegraph and Telephone Public Corp.). Proc. Japan Conf. Radioisotopes, 4th, 657-62(1961). (In Japanese)

The floor plan of the laboratory is shown. There are two similar radiation cells 2.8 m width, 2.6 m length, and 3.2 m height. A radiation cell has a labyrinth-type entrance, which can effectively reduce the scattered radiation without any shielding device. While the sources are in storage, personnel are able to enter the cell. The floor of operating area is lower than that of the cave. Non-browning glass windows, master-slave manipulators, a periscope, and a sample conveyer port are provided. The cell has plugs on the front and the roof. (T.F.H.)

29976 THE IRRADIATION FACILITY OF ORC. Kiichi Kimura, Toshio Azuma, Shigeru Okabe, Junichiro Furuta, Keisuke Kawabata, and Shinichi Okamoto (Radiation Center of Osaka Prefecture). Proc. Japan Conf. Radioisotopes, 4th, 662-5(1961). (In Japanese)

The irradiation facility of the Radiation Center of Osaka Prefecture (ORC) was built for the purpose of the studies and service of irradiation. This building contained an electron linear accelerator and a Co-60 source of 4810 curies. The Linac was to have 15 Mev energy and 8 kw power. This building had three independent foundations, for the Linac room, Co-60 irradiation room, and study rooms, respectively. (T.F.H.)

29977 NUCLEAR FACILITIES DESIGN METHODS BASED ON RADIATION SHIELDING. Masaaki Sakuta (Taisei Construction Co.). Proc. Japan Conf. Radioisotopes, 4th, 666-9(1961). (In Japanese)

Considering the design of nuclear industry facilities, it is necessary to add two design factors for safety—protection of radiation and protection from contamination—onto the other design factors of common facilities (buildings and equipments). Fundamental design techniques of nuclear industry facilities, including buildings and equipments, based on the techniques of protection of radiation are studied. (T.F.H.)

29978 DESIGN OF RADIOISOTOPE PRODUCTION PILOT PLANT. Kenjiro Kimura, Tsutomu Mochizuki, Nagao Shibata, Hidehiko Nomi, Hideo Oike, and Tomonori Takeda (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 670-4(1961). (In Japanese)

The design features of the radioisotope production pilot plant, which is being placed in operation, are abstracted. (T.F.H.)

29979 DESIGN OF RADIOISOTOPE PRODUCTION FACILITIES IN THE RADIOISOTOPE PRODUCTION PILOT PLANT. Kenjiro Kimura, Tsutomu Mochizuki, Nagao Shibata, Hidehiko Nomi, Hideo Oike, and Tomonori Takeda (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 674-7(1961). (In Japanese)

Radioisotope production facilities are described that are designed from an unconventional standpoint. These facilities are installed in the radioisotope production pilot plant, Japan Atomic Energy Research Institute, Tokai-mura, Japan. They consist of four parts: inner boxes in which the preparation and dispensation processes of radioisotopes are carried on; shielding plate at both sides of inner box for biological shielding; side plate between inner boxes; and gastight plate inserted between the front shielding plate and the inner box. (T.F.H.)

29980 ON THE HOT LABORATORY OF RIKKYO UNIVERSITY ATOMIC INSTITUTE. Tetsuo Takaishi and Tatsuo Matsuura (Rikkyo Univ. Atomic Inst.). Proc. Japan Conf. Radioisotopes, 4th, 677-82(1961). (In Japanese)

The outline of the laboratory of Rikkyo University Reactor is reported, as well as the results of tests of shielding, ventilating system, etc. (T.F.H.)

29981 THE ISOTOPE LABORATORY AT THE TSING HUA UNIVERSITY. Si-jung Yeh (National Tsing Hua Univ.). Proc. Japan Conf. Radioisotopes, 4th, 683-7(1961). (In English)

In connection with the construction of a 1-Mw nuclear reactor, completed in November 1960 at the National Tsing Hua University, an isotope laboratory is established. The laboratory consists of the following four divisions: a radioisotope production laboratory; a hot cell; a waste disposal laboratory; and a research laboratory for radiation chemistry. The design and function of each laboratory is described. (JAIF)

29982 ON THE RADIOACTIVE DECONTAMINATION WITH NATURAL INORGANIC MATERIALS. Hidehiro Goto, Shin Suzuki, Yasushi Inoue, and Mokuyoshi Kishimoto (Tohoku Univ.). Proc. Japan Conf. Radioisotopes, 4th, 692-7(1961). (In Japanese)

For the decontamination of radioactive waste solutions, natural inorganic substances, having adsorbing or ion exchange properties, are frequently used because of their abundance in nature, cheapness, and stability against strong radiation and high temperature. Besides these characteristics, these substances can be solidified with cement, and radioactive substances adsorbed on them can be fixed and transformed into insoluble state. The availability of these substances for radioactive decontamination is studied. Samples used for this investigation are some kinds of natural sands, clays, and clay minerals. Clay minerals such as bentonite and kaolin, which have uniform particle size of 300 mesh, are transformed into hydrogen form and the other samples, powdered into 100 mesh or finer, are used without any chemical pretreatment. For these substances, the decontamination factor (defined as activity adsorbed on adsorbent/activity initially present in the solution) is examined on fission product solution. It is concluded that the sand studied may be used for the decontamination of low level radioactive waste solution. (JAIF)

29983 EFFECT OF SULPHURIC ACID AND CHROMIC ACID MIXTURE TREATMENTS OF PLASTICS ON THEIR WETTABILITY AND RADIOACTIVE CONTAMINATION. Teruo Tsunoda, Tsutomu Seimiya, and Tsunetaka Sasaki (Tokyo Metropolitan Univ.). Proc. Japan Conf. Radioisotopes, 4th, 697-701(1961). (In Japanese)

The effects of sulfuric acid treatment of polystyrene, and chromic acid mixture treatment of polyethylene, for the wettability in water and the contamination by radioactive cobalt chloride were studied. The adsorption of Co-60 ions on the polystyrene both with and without surface treatment was studied. Radioactive decontamination experiments were also conducted using several rinsing liquids. It was concluded that the adsorption of Co-60 ions on the polystyrene surface treated with sulfuric acid was ion-exchange adsorption. Diagrams were constructed between the wettability of the surface and the degree of surface attack, which could be explained according to wetting isotherms proposed. (JAIF)

29984 INVESTIGATIONS ON THE CUMULATIVE AMOUNT OF Sr-90 IN TAIWAN AREA. S. C. Lu (Taiwan Weather Bureau) and D. H. Lin. Proc. Japan Conf. Radioisotopes, 4th, 701-3(1961). (In Japanese)

Soil samples are collected at a depth of 5 and 10 cm from 8 sampling stations, and a number of radiochemical analyses are made. The radioactivity of these soil samples is detected with a G-M counter. The correlations between the cumulative amount of Sr-90 and the amount of precipitation is also computed. The general distribution of the cumulative amount of Sr-90 in the Taiwan area is illustrated. (T.F.H.)

29985 ON THE COUNTING EFFICIENCY AND ARRANGEMENT OF THE COUNTER TUBES OF THE HAND AND FOOT MONITOR. Iwao Otsuka and Katsuyuki Nakai (Inst. of Physical and Chemical Research). Proc. Japan Conf. Radioisotopes, 4th, 707-9(1961). (In Japanese)

The counting efficiency and arrangement of the counter tubes of a low-energy beta-gamma Hand and Foot Monitor is discussed. The tested monitor is designed for low-energy beta rays by using a semi-cylindrical side-mica-window Geiger-Müller counter tube. Dimensions of the counter tube are 182 mm in length and 45 mm in diameter, and there are five mica windows in its side. The arrangement of the counter tubes is conventional. That is, two groups (four tubes) are used for each hand and one group (two tubes) is used for each foot. The separation of the two counter tubes in one group is 54 mm, and the two groups for each hand are apart 130 mm. (T.F.H.)

29986 LIQUID SCINTILLATION COUNTING OF TRITIUM. Masaharu Okano (Inst. of Physical and Chemical Research). Proc. Japan Conf. Radioisotopes, 4th, 710-12(1961). (In Japanese)

The advantages and drawbacks of liquid scintillation counting of tritium are enumerated. It is shown how to determine the counting efficiency by using an external gamma source, instead of internal standards. (T.F.H.)

29987 MEASUREMENT OF TRITIUM USING IONIZATION CHAMBERS. Fumio Yamasaki, Tatsuji Hamada, Masaharu Okano, and Tan Takahashi (Inst. of Physical and Chemical Research). Proc. Japan Conf. Radioisotopes, 4th, 716-20(1961). (In Japanese)

The technique devised consists in the generation of hydrogen gas by the reaction between the tritiated water sample and metallic calcium or zinc, followed by measurement of the ionization current produced in a chamber filled with the gas. Ionization currents are measured both with a Lauritsen electroscope and vibrating reed electrometer. (JAIF)

29988 COMPACT LOW-LEVEL BETA RAY COUNTING ARRANGEMENT WITHOUT USING ANTI-COINCIDENCE CIRCUIT. Hiroo Sato, Yukio Moritsugu, and Kiyoshi Kanno (Nihon-Musen Irigaku Kenkyujo, K.K.). Proc. Japan Conf. Radioisotopes, 4th, 720-3(1961). (In Japanese)

A beta counter and a specially designed guard counter are described that have a small size and that eliminate the natural background. A low-level beta counting assembly with only one high-voltage supply and without any anti-coincidence circuit is developed. Its performance is not appreciably different from that of ordinary low-level counters. (T.F.H.)

29989 LOW BACKGROUND END-WINDOW G-M COUNTER AND LARGE-AREA END-WINDOW G-M COUNTER. Jiro Yuhara (Japan Defense Agency, Tokyo), Yukio Moritsugu, and Kiyoshi Kanno. Proc. Japan Conf. Radioisotopes, 4th, 723-6(1961). (In Japanese)

For low-level beta counting, it is necessary to reduce the background of the G-M counter as low as possible without deteriorating the characteristics of the counter. Counters of special types – low background and large area – are devised for this purpose. (JAIF)

29990 ON THE PROBLEMS OF THE RADIOACTIVITY RATE MEASURING TECHNIQUES AND THE CONSEQUENT

STATISTICAL TREATMENTS. Chueh-ming Wang (National Taiwan Univ.). Proc. Japan Conf. Radioisotopes, 4th, 727-38(1961). (In Japanese)

The frequency distribution of the radioactivity rate is assumed to obey the Poisson error law. This argument is verified in certain measuring experiments, chosen such that the measured frequency distributions of the radioactivity rate follow given patterns. (T.F.H.)

29991 MEASUREMENTS OF LARGE DOSE ELECTRON BEAMS. Yohta Nakai, Harumi Inomo, Koji Matsuda, Michikazu Hiraoka, Toshihiro Ohsuga, and Kiichi Kimura (Japanese Assn. for Radiation Research on Polymers, Osaka). Proc. Japan Conf. Radioisotopes, 4th, 739-41 (1961). (In Japanese)

Studies were performed for the determination of radiation doses absorbed in matter, for electron beams from Van-de-Graaff-type accelerators. For absolute measurements both "depth dose" and calorimetric methods were used, and for secondary or routine dose measurements the method of coloration of polyvinyl chloride films by ionizing radiation was developed. (T.F.H.)

29992 SPECIAL DISTRIBUTION OF ELECTRON DEPTH DOSE IN A FEW KINDS OF MATERIALS. S. Tono, Yoshio Tsuji, Toshikazu Higashino, and Takeo Matsubara (Sumitomo Electric Industries, Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 742-4(1961). (In Japanese)

Using incident electrons in the energy range 1.0 to 2.0 Mev, the distribution of energy dissipation of electrons against various thickness for a few kinds of materials are measured. The energy loss of electrons below 2 Mev may be mainly caused by multiple scatterings, by which the electrons are scattered through a small angle, the large angle scattering being negligibly small. (T.F.H.)

29993 ON SOME CHARACTERISTICS OF A DIRECT READING X–γ DOSE AND DOSE-RATE METER. Shinichi Shimazu, Hideo Ueyanagi, Kenshi Nakamura, and Seiji Kawamura (Shimadzu Seisakusho Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 745-7(1961). (In Japanese)

A type of direct-reading x–γ dose- and dose-rate-meter is described. This apparatus can be used for measurement of x and γ rays from 30 to 2000 kev, and the full scale of the dose-rate indicator covers 100 mr/hr to 1000 r/min. To cover such wide range of energies and dose rates, 10 probes are required. Total doses are given by a mechanical register driven by a two-phase servomotor, whose numbers of revolution per unit time are proportional to the dose rate at the every moment, stabilized by a tachometer generator directly coupled with its axis. The register indicates 100 digits when the dose-rate indicator constantly shows the full scale deflection for 1 minute. This mechanical integration method has an advantage over an electrostatic condenser integration, because no electric current leakage can occur. Mechanical integration, however, is not possible with a very small dose rate, because in this case the servomotor will not rotate. In order to overcome this difficulty, many probes are prepared, one of which gives an adequate output voltage for integration. (JAIF)

29994 DESIGN OF BELL ALARM METER FOR PERSONAL MONITOR. Kentaro Minami (Japan Atomic Energy Research Inst.) and Toshinori Oshima. Proc. Japan Conf. Radioisotopes, 4th, 748-50(1961). (In Japanese)

This meter is designed for personal protection at high-level gamma or x-ray field, such as nuclear reactors in an emergency. Therefore, the maximum dose setting is 2.4 roentgens. A second model is designed for personal protection in general isotope treatment. The electronic circuit is the same one as used in the higher-level dose model, except for simplification of the charger part, which simplification dispenses with the charge-reader. (T.F.H.)

29995 THE LATENT IMAGE FADING OF γ-RAY FILM BADGE IN RELATION TO THE MEASUREMENT OF DOSE FOR THE PERIOD OF THREE MONTHS. Toru Sueyoshi (Fuji Photo Film Co., Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 750-4(1961). (In Japanese)

In the case of measurement of radiation exposure for three months by means of photographic film badge, it should be noticed that the latent image regression of the photographic film is greater, and may cause more influence on the calculation of dose, than in the measurement of weekly exposure. An experiment on the degree of latent image fading over a period of three months has been carried out for three types of films, viz. γ-ray badge film and two films of less sensitivity, under various humidities at room temperature. The effects of the activity of developer and photon energy on the extent of latent image regression of exposed films is studied. (T.F.H.)

29996 LIQUID MONITOR. PART 1. MECHANISM OF NEW TYPE INSTRUMENT. Yuzo Tajima, Hatsumi Tatsuta, Morinobu Kokubun, and Kentaro Minami (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 754-7(1961). (In Japanese)

It is necessary for a liquid monitor to detect all the radioactivity in high sensitivity, in short time, and in simplicity. A monitor is described that satisfies all the conditions fairly well. The liquid is led into the hot air stream, where it is vaporized in a moment and then changed to dust. This dust is collected on a filter paper and sent to the detector. At the air inlet, this instrument has an absolute filter in order to remove the effect of Rn and Tn daughter. Since continuous operation is desired, the required sampling time must equal the counting time. (T.F.H.)

29997 LIQUID MONITOR. PART 2. EXPERIMENTAL RESULTS. Yuzo Tajima, Hatumi Tatsuta, Morinobu Kokubun, and Kentaro Minami (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 4th, 757-62(1961). (In Japanese)

This instrument has an absolute filter at the air inlet. By this device the amount of the background count caused by Rn and Tn daughter can be neglected for sample counting The dust and radioisotopes separated from water are collected on a high-efficiency filter. The filter-paper samples are measured by a low-background GM tube. The detectable amount of radioactive isotopes in twenty minutes counting is 4×10^{-8} μc/cc for a β-ray emitter, with 10% probable error. (JAIF)

29998 SCINTILLATION CAMERA. Noboru Tokunaga, Norimasa Nohara, and Mizuki Mori (Nihon-Musen Irigaku Kenkyujo, K.K.). Proc. Japan Conf. Radioisotopes, 4th, 762-5(1961). (In Japanese)

An important problem in the scintillation camera is to determine exactly a scintillation image, in such a way that the photopeak scintillation caused by gamma-rays is reproduced as a point flash of light on the cathode ray tube screen in the same relative position as the original scintillation in the crystal. In this case, Compton process and scattered γ-ray pulses are eliminated by the pulse-height selector, and only photopeak pulses passes through the selector. The amount of light accepted by a bank of photomultiplier tubes is not equal at any point on the surface of crystal. For the purpose of avoiding such fault, in an im-

proved scintillation camera nine photo-multiplier tubes are arranged in a certain formation. By the aid of the matrix circuit the (X,Y) coordinate can be determined, then a flash point is reproduced on cathode ray tube. (T.F.H.)

29999 NEW DEVICES OF SCINTISCANNER ESPECIALLY ON A MEMORY DEVICE OF SCINTIGRAMS. Sigemasa Nakanishi, Shinichi Shimazu, Hideo Inoue, Hideo Ueyanagi, Takao Masui, and Fumio Maruoka (Shimadzu Seisakusho Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 765-9(1961). (In Japanese)

A scintiscanner is developed by design principles that achieve good contrast on its scintigrams. Those techniques are as follows: to obtain a high sensitivity and a sharp collimation for γ rays, a 3" (diameter) × 3" (height) NaI (Tl) scintillator and a tapered-honeycomb-focused collimator of 39 holes from lead are used; to keep a space between each trace of the detector scanning constant, a control on the number of rotations of the driving screw is used; and to obtain a clear contour of the object on its scintigram, 3 ways of background elimination are used. (T.F.H.)

30000 IMPROVEMENTS OF PLATEAU OF THE GAS FLOW COUNTERS. Shuji Yamada, Tsunetaka Wajima, and Munemaro Imai (Hitachi Central Research Lab., Tokyo). Proc. Japan Conf. Radioisotopes, 4th, 769-72(1961). (In Japanese)

Plateau characteristics of proportional counters depend on the internal construction of the counters and also on the specification of amplifiers used. Experiments are carried out using gas-flow counters in order to investigate overload characteristics of amplifiers, position of the center loop of the counter, overall resolving time, pulse height distribution, and so on. It is concluded that good plateau characteristics should be obtained by using an amplifier having excellent non-overload characteristics, and gains of several tens of thousands. (T.F.H.)

30001 SOME CHARACTERISTICS OF A TRANSISTORIZED SINGLE-CHANNEL PULSE HEIGHT ANALYZER. Shinichi Shimazu, Kiyoshi Hosoi, Nobuo Yokoyama, and Hideo Ueyanagi (Shimadzu Seisakusho, Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 772-5(1961). (In Japanese)

The single-channel analyzer for nuclear detectors is widely used in many radioisotope applications. Few attempts of transistorization of the single-channel pulse-height analyzer are successful, because of instability of its discrimination level. An excellently stable transistorized analyzer is described. (T.F.H.)

30002 A HIGH-SPEED MULTI-CHANNEL PULSE HEIGHT ANALYZER USING THE PULSE DELAYED SYSTEM. Yoshio Moriwaki, Tatsuo Kawamura, and Toshiaki Terakawa (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 4th, 775-9(1961). (In Japanese)

Scintillation detectors are used for detecting gamma rays. For the pulse height analysis of the high-frequency pulses from these detectors, and for the measurement of the radiation from radioisotopes of short decay time, it is required that the measurement time be short, with low counting loss. The system described with pulse holding circuits features a considerably low counting loss, and at the same time it gives less measurement time of energy analysis than that of a conventional analyzer with the highest-speed A-D converter. This analyzer consists of a linear amplifier, pulse stretchers, linear gates, an A-D converter, a discriminator, and a control circuit. (JAIF)

30003 AN FM TYPE MULTI-CHANNEL PULSE HEIGHT ANALYZER. Yoshio Moriwaki, Tatsuo Kawamura, and Shingo Mihara (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 4th, 779-84(1961). (In Japanese)

A pulse-height analyzer, which gives the energy distribution of radioactive emission with accuracy and speed by the use of a frequency-modulating-type positive-bias multivibrator, is developed. (T.F.H.)

30004 A HIGH-SPEED MULTI-CHANNEL PULSE HEIGHT ANALYZER WITH A DELAY LINE MEMORY. Yoshio Moriwaki (Tokyo Univ.), Tatsuo Kawamura, Hirohide Miwa, and Tsutomu Mizukoshi. Proc. Japan Conf. Radioisotopes, 4th, 784-8(1961). (In Japanese)

A multi-channel pulse height analyzer with a delay-line memory has the advantage of simple construction, but it has a resolving time about ten times longer than other systems as the result of the long access time of the memory device. Several systems are devised to improve the resolving time of the multi-channel pulse-height analyzer of this kind. (T.F.H.)

30005 STUDIES ON STRONTIUM METABOLISM OF RAT BONES BY RADIOACTIVATION ANALYSIS. Yoshiro Matsumura (Tokyo Women's Medical Coll.) and Reiko Fujino. Proc. Japan Conf. Radioisotopes, 4th, 794-7 (1961). (In Japanese)

An attempt was made to use neutron activation analysis of strontium as a basis of turnover study on rat bones under various nutritional conditions. Albino rats, between two and three months old, were kept in iron metabolic cages and were fed with oriental meal MF for three months at least. The femurs were carefully removed and ashed. The ashes were ground to a fine powder. Strontium standards and bone-ash samples were immediately irradiated, under neutron flux of 10^{11} n/cm^2/sec. The activated standards and samples were subjected to a radiochemical purification, which included a precipitation of nitrate and carbonate as well as barium and iron scavenging. The amount of strontium normally present in the rat femur was determined. (T.F.H.)

30006 ON THE RADIOACTIVE CONTAMINATION AT Mm. CURIE LABORATORY. Masasi Fukuda, Yoshimasa Tanaka, and Ikuo Kimura (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 4th, 797-9(1961). (In Japanese)

An attempt was made to examine the contamination of the Mm. Curie laboratory, using a copy of her treatises taken from her laboratory. It was considered that activity was attached to the copy by Mm. Curie's fingers contaminated with radioisotopes. A guess was made as to how heavily the laboratory was contaminated. (T.F.H.)

30007 USE OF ISOTOPES IN ION TRANSPORT STUDIES. A. K. Solomon (Harvard Univ.). Proc. Japan Conf. Radioisotopes, 4th, 820-7(1961). (In English)

Studies are described of the mechanism of water absorption by the proximal tubule of Necturus maculosus, using radioactive tracers. Water absorption in vivo is measured by injecting a NaCl solution, which contains inulin, into a proximal tubule blocked at both ends with stained oil droplets; the change in inulin concentration over a 20 minute period measures the net water movement. The inulin is labeled by attaching a C-14 carboxyl group to the molecule, and is counted either in a windowless flow counter or in a liquid scintillation counter. The studies in Necturus proximal tubule show that water movement is driven primarily by NaCl movement and that no other force but solute transport is involved in water absorption in this species. The question then arises as to whether the Na or the Cl ion is primarily transported. To answer this question it is

necessary to measure the electrical difference across the tubular wall, and also to measure the flux of Na and Cl in both directions across the wall. The Na fluxes are measured by using Na-24 to determine the flow of ion out of the tubular lumen, together with measurements of net changes in Na concentration. This permits calculation of fluxes in each direction. The results of these studies indicate that energy must be supplied directly to transport the Na ion. Cl is transported passively. When these results are combined with measurements of Na, K, and Cl concentration within the cell and electrical potential measurements across the separate faces of the luminal cell, it appears that the movement of these ions and the concomitant water absorption can be accounted for by a pump located at the peritubular face of the cell. This pump transports Na out of the cell while returning K to the cell in order to maintain the typical high intracellular K concentration. (JAIF)

30008 STUDY OF UPTAKE OF P-32 TO THE GONAD. Hayami Fujimori, Fumio Yamada, Shichikatsu Naito, Masataka Morimura, and M. Go (Osaka City Univ.). Proc. Japan Conf. Radioisotopes, 4th, 832(1961). (In Japanese)

The function of the gonad of both sexes is delicately influenced by slight changes of various conditions. The function of the gonad in various conditions is studied by investigations of the rate of the uptake of P-32 in the gonad. The uptake of P-32 in ovaries of female virgin albino rats treated with various sex hormones is investigated. The uptake rate in ovaries after a certain time is 1.1 in the case treated with estradiol, 1.7 with progesterone, and 1.5 and 3.3 with glandular and chorionic gonadotropine. The process of the uptake in animals treated with progesterone is examined in detail chronologically. The uptake of P-32 in ovaries of adult female rats irradiated with x rays on the region of the hypophysis-middle brain system is studied. The uptake rate is decreased 7 days after irradiation with 500 r and markedly decreased immediately after irradiation with 1000 r. The rate of the uptake of P-32 in ovaries treated with both irradiation and administration of gonadotropine or of progesterone is higher than that in ovaries treated only with irradiation or with hormones. The uptake of P-32 in the male gonad treated with some anticarcinogenic agents is examined. (T.F.H.)

30009 STUDIES ON THE LABELING OF TUBERCULIN. Kenji Yusawa, Yoshinobu Osawa, Kunihiko Yabu, Takenobu Tokunaga, and Takeo Nitani (Japan Anti-Tuberculosis Assn.). Proc. Japan Conf. Radioisotopes, 4th, 833-5(1961). (In Japanese)

The tuberculin reaction mechanism is studied by radioisotopic approach. Two methods of labeling are tried, one of them concerned with cultivation in Sauton's medium containing Fe-59, P-32, or S-35, and the other with the exposure of purified tuberculin powder to neutron beam. Among the radioactivities of tuberculins obtained from the culture filtrates, S-35-labeled tuberculin is much stronger than the others. No difference is observed in biological potency between the irradiated tuberculin and the ordinary tuberculin. The purified tuberculin treated by the latter method is radioactive with respect to the exposure time, and the tuberculin thus labeled maintains its biological activity. Biological- and radioactive-tuberculin may be obtained by these two methods. (T.F.H.)

30010 CONSIDERATIONS ON CLINICAL USES OF COLLOIDAL RADIOISOTOPES. Tadashi Miyakawa (Tokyo Univ.) and Yasuo Yoshizawa. Proc. Japan Conf. Radioisotopes, 4th, 873-5(1961). (In Japanese)

Physico-chemical properties of radiocolloids are important in a clinical use. Colloidal gold-198, yttrium-90, and lutetium-177 are used for clinical applications. Colloidal gold-198 is more stable than the other two colloidal radioisotopes. An attempt is made to study the relationship between distribution in animals and pH of the rare-earth colloidal radioisotopes Y-90 and Lu-177. (T.F.H.)

30011 STUDIES ON THYROID VOLUME BY SCINTILLATION SPECTROMETER. Bijon Roy and Ajoy Choudhury (Inst. of Post-graduate Medical Education and Research, India). Proc. Japan Conf. Radioisotopes, 4th, 887-9(1961). (In Japanese)

The study on thyroid volume consists of measuring the scatter component from the thyroid gland by differential scanning after the subject has swallowed a dose of radioactive iodine (I-131), and then to find out the gland volume from the calibration curve, in contrast to other available methods, namely palpation and scintiscanning measurement in two planes. The aim of the work is to predict the dose accurately in treating thyroid diseases by irradiation, since the source of greatest inaccuracy in the prediction of dose lies in the determination of gland volume. The differential scans are carried out using a scintillation spectrometer. The differential scan from a thin film source of I-131 shows four gamma energy peaks. On extending the source (increasing the volume) keeping the activity of the radioactive material and other factors constant, the energy below the photopeak shows increased activity because of scattering effect in the material and the content of the phantom. The above scan, when repeated with phantoms of different volume capacity, yields a calibration curve of percentage scatter vs. phantom volume. The percentage scatter from the thyroid gland obtained from a scan from the thyroid of the subject who has swallowed a dose of radioactive iodine then gives a measure of the thyroid volume as obtained from the calibration curve. (T.F.H.)

30012 IODINE-125. P. V. Harper, Warren D. Siemens, Katherine A. Lathrop, H. E. Brizel, and R. W. Harrison (Argonne Cancer Research Hospital). Proc. Japan Conf. Radioisotopes, 4th, 902-11(1961). (In English)

There may be some advantage in substituting iodine-125 for iodine-131 in a number of clinical and experimental situations. Among these advantages are: the long half life of iodine-125 (60 days), which results in a greatly increased shelf-life of tagged compounds; the low energy (27 kev) of its photon radiations, which reduces shielding requirements and permits more efficient detector design; and the low energy dissipation rate, which reduces radiation damage to tagged compounds. These factors allow enhanced counting efficiency and scanning resolution and lead to decreased radiation dosage and increased tolerable isotope dosage. The availability of the isotope, however, is greatly limited because production in the cyclotron from tellurium, even when enriched target material is used, results in heavy contamination with the undesirable 13-day iodine-126, making the resultant product unsuitable for human and experimental use to a considerable extent. The production is described of iodine-125, as a daughter product from the neutron activation of xenon-124 to xenon-125. This method makes available curie quantities of material with greater than 98% purity at a cost of approximately five dollars a millicurie. The thermal neutron activation cross section of xenon-124 is found to be 115 barns with a resonance activation integral of 1210 barns. While this permits production of large amounts of iodine-125, unfortunately

the product iostope itself has a high thermal neutron activation cross section of 890 barns and a resonance activation integral of 6500 barns, so that iodine-126 formation from iodine-125 must be limited by shortening the activation time or lowering the neutron flux. (T.F.H.)

30013 DIAGNOSIS OF CANCER USING BREMSSTRAHLUNG OF P-32. Shuji Kimura, Ichihei Matsumoto, Akira Tominaga, Naohiko Takahashi, and T. Maeda (Kobe Medical Coll.). Proc. Japan Conf. Radioisotopes, 4th, 915-18(1961). (In Japanese)

A method for the detection of cancer by external survey with a γ spectrometer of the bremsstrahlung from P-32 was tried. Clinically this method is effective only for shallowly situated cancer, and does not give clear enough peaks for definitive diagnosis of more deeply situated lesions. (T.F.H.)

30014 DOSE DISTRIBUTION OF TELECOBALT ARC THERAPY. Yasuto Onoyama, Susumu Morikawa, and Noboru Kawakatsu (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 4th, 927-31(1961). (In Japanese)

Because of a skew dose distribution and maximum dose displacement in arc therapy, it is important to know a complete dose distribution. During arc therapy, both the source-skin distance and the field size on the skin vary continuously, so there is need of depth dose tables of numerous source skin distances and field sizes to calculate dose distributions. But it is practically impossible to use such a number of measured depth dose data. The difficulty is overcome by calculating these data from tumor air ratios at rotation center. The tumor air ratio in acrylite, used as a body phantom, is an exponential function of the tissue depths beyond 14 cm depth, and the effective absorption coefficient, μ, for that field size is obtained from the slant of this curve. The build up of the scatter accounted for the deviation from this relation in the region from 0 cm to 14 cm depth. Curves are obtained from which the tumor air ratio at any point along the central beam axis can be read. The calculated depth dose curves agree with measurements on the same source skin distance and field size. (T.F.H.)

30015 DOSIMETRY FOR A TOTAL-BODY IRRADIATION CHAMBER USING CESIUM-137. S. K. Wang, M. L. Jacobs, and Leon Pape (City of Hope Medical Center and Post Graduate Medical School, USA). Proc. Japan Conf. Radioisotopes, 4th, 940-5(1961). (In English)

For uniform irradiation to the whole body, a special chamber is constructed. The chamber is approximately 11 ft × 11 ft. It contains four wells, 12 ft deep. In each well, a steel rod rides up and down on a chain-drive mechanism. The four rods house at either end, and 6 ft apart, a 300-C cesium-137 source in a standard source container. The sources are stored, when not in use, in the wells. Controls are outside the chamber. To study the dose distribution, a full size mannequin is constructed. With no beam absorbers, the maximum variation from the central dose rate is only 26%. The addition of a $\frac{1}{8}$ in. lead beam absorber gives only slightly better distribution. However, with addition of a central absorber, a sharp improvement is found. With a $\frac{1}{4}$ in. lead plate plus a $\frac{1}{4}$ in. thick convex circular central beam absorber, the maximum variation from central to peripheral dose is only 9%. To consider the variation off the central axis, a pressed wood cross-section is fabricated. A series of isodose patterns are made using the central volume as representative. With a $\frac{1}{8}$ in. lead beam absorber, the variation is ±8%. With a proper beam shaping device and beam absorber, a uniform dose distribution of radiation is achieved. (JAIF)

30016 BIOSYNTHESIS OF RADIOACTIVE ORGANIC COMPOUNDS BY THE USE OF MICROORGANISMS. Hajime Takahashi, Toshie Hattori, and Bunji Maruo (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 4th, 957-62(1961). (In Japanese)

A method for the cultivation of Chlorella and other photosynthetic cells with C-14 carbon dioxide as a sole source of carbon is developed. The device has no circulating system, and all connections are glass to glass. Thus the leakage problem is minimized. Up to 40 mC of carbon dioxide (4.57 mM) is utilized for each Chlorella culture. After the culture, the cells are poured into boiling 80% ethanol. Ethanol soluble fraction is further fractionated into water-soluble and chloroform-soluble fractions. The former consists mainly of sugars and the latter contains lipids and pigments. Nucleic acids are extracted from the ethanol-insoluble material by hot trichloroacetic acid. The resulted protein fraction is hydrolyzed by a protease from Streptomyces. The protease digest is dialyzed against water in order to remove the enzyme. The dialyzate contains amino acids and peptides. The non-dialyzable soluble fraction is also made up of peptides. The insoluble material from protease treatment, i.e., cell wall fraction, gives sugars and amino acids upon acid hydrolysis. The distribution of radioactivity in these fractions is summarized. The yield of each fraction differed considerably from culture. For example, the yield of protein hydrolyzate ranged from 10 to 25% of the applied radioactivity. (JAIF)

30017 STUDIES ON THE BIOSYNTHESIS OF LIPOPROTEIN OF TUBERCLE BACILLI. Hideo Maeda (National Sanatorium Toneyama Hospital), Junkichi Tani, and Yuichi Yamamura. Proc. Japan Conf. Radioisotopes, 4th, 968-71(1961). (In Japanese)

The incorporation of labeled amino acid into the lipoprotein fraction by tubercle bacilli is examined. When tubercle bacilli are incubated with the radioactive amino acid, radioactive lysine is found to be incorporated readily into this fraction. The paperchromatogram of this radioactive lipoprotein shows that there are at least three components detected by ninhydrine development and that each of them is radioactive, but no free lysine is found. In the paperchromatogram of the acid hydrolysate of this lipoprotein, there are found nine spots detected by ninhydrine development. Two of them are highly labeled, and one is identified as lysine. The labeled amino acid is concluded to be tightly bound in the lipoprotein fractions. It is conjectured that in tubercle bacilli, the RNA fraction, containing RNA-amino acids complexes, should not be expected to be a precursor of the lipoprotein, and it is thought that some component in the phenol-soluble fraction might have a role in the lipoprotein synthesis. (T.F.H.)

30018 DYNAMIC ISOTOPE TECHNIQUES IN STUDIES OF PROTEIN METABOLISM. Robert W. Swick (Argonne National Lab., Ill.). Proc. Japan Conf. Radioisotopes, 4th, 977-8(1961). (In English). (TID-14401)

The technique of continuous administration of tracer materials to animals for relatively long periods makes it possible to establish certain precursor-product relationships and, for short periods, to measure quantitatively the velocities of some metabolic reactions. This report is concerned with the use of isotopic carbon dioxide in the measurement of the turnover rates of several proteins that originate in the liver. Intracellular carbon dioxide is incorporated without dilution into the guanidine group of free liver arginine and may be released as urea or incorporated into protein. Since the equilibration of intracellular carbon dioxide is rapid and the amount of free arginine is small,

the specific activity of the guanidine group of free arginine also quickly reaches equilibrium and remains constant for the duration of the experiment. Its specific activity may be ascertained at any time from the specific activity of excreted urea. Because these conditions satisfy most of the criteria for the unequivocal measurement of renewal rates it was possible to measure these rates in several liver proteins under a number of conditions. Rats are exposed continuously to $C^{14}O_2$ by being trained to consume a diet containing $CaC^{14}O_3$, distributed in limited but adequate amounts among 24 cups placed on a device moving one station each hour. After exposure periods of 1 to 30 days, the animals are sacrificed, and the specific radioactivity of the guanidine group of arginine isolated from various proteins is compared to that of excreted urea. Heterogeneity in the metabolism of liver proteins is apparent in that the turnover rates of the total, mixed proteins of rat liver vary according to the length of exposure to isotope, although it is clear that nearly all of the proteins exhibit a rapid renewal rate. On the other hand, albumin, which originates in the liver, is a single species of protein whose metabolism is subject to random processes. In this case, the turnover rate is 27 to 29% per day. (T.F.H.)

30019 STUDIES ON ELIMINATION OF RADIOACTIVE CESIUM. (2nd Report). Eiichi Ogawa, Shiro Suzuki, Ryuzo Fukuda, and Katsuhiro Shibata (Gunma Univ.). Proc. Japan Conf. Radioisotopes, 4th; 996-1000(1961). (In Japanese)

Pharmacological means to accelerate the elimination of Cs-137 introduced into the living organism are studied. Male dd mice and male Wistar rats are individually housed in metal metabolism cages, and provided with commercial solid diet and water. Radioactivity is determined in urine, and feces for 24 hours and 4 days after subcutaneous injection of a tracer dose of $Cs^{137}Cl$, and in various organs after sacrifices at the ends of these periods. Effects of various chemicals on these results are compared. Twenty five chemicals were investigated. They include inorganic Na salts such as Na bicarbonate, Na carbonate, Na sulfate, Na thiosulfate, primary and secondary Na phosphates, and organic Na salts such as Na lactate, lactated Ringer, Na acetate, Na glucuronate, Na salt of thioctic acid, ATP Na, and Na pentobarbiturate. Na bicarbonate, Na phosphates, Na sulfate, and Na thiosulfate are found as effective, especially Na bicarbonate. K bicarbonate shows scarcely any effect, nor do other K salts. It is therefore assumed that Cs will exchange with Na ion in the tubular cells. LiCl is found to accelerate the excretion of Cs-137 from mice and rats. This result is of interest with respect to the periodic law, since it is known that for the elimination of Sr-90, Ca salts are ineffective or slightly effective, whereas Mg salts are effective. Of the diuretics, chlorothiazide, which is considered to increase the excretion of K, does not increase the elimination of Cs-137 in any dose. This result is different from that of Diamox, a diuretic of the same nature. Cardiac glycosides and xanthine derivatives are effective. Out of digitalis preparations, Digitamin (Shionogi), Digilanogen C (Fujisawa), Digosin (Chugai) are effective. Digitoxin and strospeside are ineffective, and after their application, retention of Cs-137 is observed in the heart muscle. G-strophanthin is ineffective in a smaller dose, but increases the elimination of Cs-137 in a larger dose. Caffeine and sodium benzoate are also effective, but theophylline and theobromine are not so effective. Out of osmotic diuretics, Na ferrocyanate alone increases fecal excretion of Cs-137, and decreases the retention in the body. NaI and KI have scarcely any effect. Phosphomolybdic acid inhibits the elimination of Cs-137 and increases its retention. The above mentioned effective chemicals are also investigated for effects on the elimination of Sr-90. (JAIF)

30020 EFFECTS OF NUCLEOTIDES ON RADIATION PROTECTION. Yoshimasa Tanaka and Mitsuyuki Abe (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 4th, 1004-7(1961). (In Japanese)

It is considered that one of the most prominent phenomena provoked by radiations is damage to DNA synthesis. Radiations affect markedly nucleotide metabolism of organisms. An experiment is carried out to test whether the precursors of nucleic acids are protective against radiation damage. Uridylic acid (UMP) and Cytidylic acid (CMP) are employed in this study. The experimental animals used in this experiment are dd strain mice, irradiated with a single dose of 600 or 750 r from a Co-60 source. Ten days chick embryonic hearts are cultivated, and the explants were divided into 3 groups. CMP and UMP of the first group added to nutrient medium are 30' before irradiation (10^4r); CMP and UMP are added to the second group 30' after irradiation (10^4); and the third group is unirradiated controls. Mitotic rations and histological findings among these 3 groups are examined. (JAIF)

30021 ON THE RADIATION INJURY TO MEMBRANE PERMEABILITY FOR ELECTROLYTES (Na-22, Cl-36). Giichi Yoshii and Machiko Miyachi (Osaka Univ.). Proc. Japan Conf. Radioisotopes, 4th, 1008-11(1961). (In Japanese)

The cell membrane plays a prominent role in the cell activity. The intracellular content of electrolytes, as contrasted with that in the surrounding liquid, are produced by two types of mechanisms, active transport and passive transport. The former is characterized by Na-transport as a so-called "sodium pump" and the latter by Cl-transport between the outside and inside of the cell. The radiation effect of various dosages on the mechanism of ion transport in rat blood cells is studied. When a small amount of Na-22 is introduced into the blood plasma in vitro, the isotope appears increasingly in the cellular fraction in proportion to the dosage of irradiation (5 to 320 kr). On the contrary, when blood cells labeled by Na-22 are put into the plasma, the isotope content remains at a constant level in the plasma when irradiated. The same experiments are undertaken using Cl-36. However, in this case no difference is recognized between the irradiated samples and the controls. These experiments indicate that by irradiation, the functioning of the sodium pump, in other words the active transport, is blocked. (JAIF)

30022 THE POSSIBILITY OF ACTIVATION ANALYSIS AS A TOOL IN THE BIOCHEMICAL SCIENCES. H. D. Bruner (Div. of Biology and Medicine, AEC). Proc. Japan Conf. Radioisotopes, 4th, 1014-18(1961). (In English)

Activation analysis as a tool for low-level analysis of certain elements is discussed. The availability of reactors together with development of reliable γ spectrometry is leading to interest in the possibilities of activation analysis for very-low-level detection. The literature is reviewed in relation to a discussion of the present and probable future of the technique in the biomedical field. (T.F.H.)

30023 TRITIUM COUNTING IN MEDICAL SAMPLES. Masaki Kasima (Tokyo Univ.) and Yung-ho Kang. Proc. Japan Conf. Radioisotopes, 4th, 1019(1961). (In Japanese)

Tritium is a β emitter with maximum energy 18 kev, but an improvement of measurement reveals that tritium is

a useful nuclide for practical use. Any facile measurement is desirable for the purpose of clinical application. Measurement methods are studied that are applicable for routine work, using a liquid scintillation counter and vibrating-reed electrometer, for biological materials. Counting efficiencies of scintillators are determined. The liquid scintillation counter is proved to be more appropriate for routine work because of the easiness of measurement. (T.F.H.)

30024 THE DESTINATION OF I-131 GIVEN TO THE LAYING HEN. WITH REFERENCE TO THE AMOUNT ACCUMULATING IN THE EGG. Hiroshi Nozaki and Masaharu Oshima (National Inst. of Agricultural Sciences). Proc. Japan Conf. Radioisotopes, 4th, 1023-7(1961). (In Japanese)

Iodine is ordinarily contained in the hen's egg as a trace element. However, if hens are fed on a diet containing much iodide the I content rises to thousands of times that of the ordinary egg. Eggs laid by hens subjected to thyroid-function studies using I-131 administration sometimes show high radioactivity. After single intra-muscular injection of Na I-131, the amount of I-131 passed to the egg changes daily along a sharp convex curve, and later than 10 days after injection it decreases along a straight line. The maximum I-131 in an egg amounts to 2 to 3 percent of dose 4 or 5 days after injection, and 12 to 25 percent of I-131 in total transfer to the eggs laid until 10 days after injection. The amount of I-131 transferring to the egg varies according to the season, mode of dosing, and the administration of non-radioactive iodine. I-131 accumulation in the ovary and the maximum amount of I-131 in an egg following hen's repeating I-131 intake are also studied. (T.F.H.)

30025 THE EFFECT OF γ-IRRADIATION ON ALCOHOLIC BEVERAGES AND ITS POTENTIALITY FOR PRACTICAL APPLICATION. Yoshishige Okazawa, Mitsuo Namiki, Shigeji Iida, and Akira Matsuyama (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 4th, 1042-5(1961). (In Japanese)

Generally, changes in flavor and taste of alcoholic beverages caused by irradiation of Co γ rays are remarkable. In the case of Sake (Japanese rice wine), artificial Sake, and wines, occurrence of off-flavor and deterioration in qualities are unavoidable when they are irradiated more than about 5×10^4 r. However, maturing of taste and improvement of qualities by irradiation of relatively lower doses are found. The suitable dose range for maturing effect depends on the condition of materials exposed to irradiation, and in order to prevent off-flavor development, substitution of gas phase during irradiation seems to be effective. Similar maturing effects are obtained with many distilled liquors. The maturities are markedly promoted with doses of 1×10^5 to 3×10^5 r. As doses become greater, losses of characteristic original flavor and stimulative tastes are observed. Radiation effects are able to improve qualities of Sho-chu spirits (distillates of ferment mashes prepared from rice and sweet potato). The changes of whiskies and brandies caused by γ irradiation, immediately after distillation and before storage, are of interest. Flavor change is similar to that occurring in the early period of storage in barrels, and the maturity is equal to that of beverages stored several years. Chemical analysis of components and measurements of physical properties are carried out in relation with the changes in flavors and taste. (JAIF)

30026 PHYSIOLOGICAL STUDIES ON THE STORAGE OF AGRICULTURAL PRODUCTS TREATED WITH GAMMA-RAYS. Kuniyasu Ogata, Takashi Iwata, and Kazuo Chachin (Osaka Univ.). Proc. Japan Conf. Radioisotopes, 4th, 1045-50(1961). (In Japanese)

There is a possibility to improve the storage condition of fruits or vegetables through the control of ripening by irradiation, and many problems remain to be solved about the physiology of the fruit-ripening process. The effect of gamma rays is observed in reference to these points on bananas and Japanese persimmons. Sprout-inhibiting effects on onions and potatoes are also studied. (T.F.H.)

30027 EFFECTS OF CHEMICAL AGENTS ON RADIATION STERILIZATION OF MICROORGANISMS. Mitsuo Namiki (Inst. of Physical and Chemical Research, Tokyo), Yoshishige Okazawa, Ichiro Kaneko, and Akira Matsuyama. Proc. Japan Conf. Radioisotopes, 4th, 1050-3(1961). (In Japanese)

Aiming at the reduction of sterilization dose by means of enhancing total lethal effect of radiation with chemical agents, the effects of various inorganic and organic compounds on radiation inactivation of microorganisms are studied. Experiments are performed by using E. coli and Z. soya as test microorganisms, and the survival fraction is measured after exposed to γ rays from Cobalt-60 with the 1% survival dose. Viable counting is carried out by the capillary tube method for the bacterium and the plate method for the yeast. The effects of salt concentration, cell concentration, oxygen, dose rate, and combined treatment with other compounds on the synergistic effect of NaCl are investigated. Among the inorganic reagents tested, synergistic effect with radiations is also observed with heavy metal cations and hydrogen peroxide. Most of organic compounds seem to have a more or less protective effect against radiation inactivation at higher concentrations, whereas synergistic effects are found with chloral hydrate, phenol, and its halogen derivatives. The relationship between the addition effect and the chemical structure is investigated by using various types of aromatic and aliphatic compounds, and their halogen derivatives. In connection with the synergistic action of alkali halides to radiation inactivation, the following studies are also performed; actions of various chemical agents on combined effect of radiation and NaCl, effect of alkali halides on $G(H_2O_2)$ value with radiolysis of water, protective effect of halides on radiation inactivation of enzyme in aqueous system, enhancing effect of halides on radiolysis of SH-compounds, microelectrophoretic behavior of irradiated cells, and survival curves under various conditions. From these observations, the mechanism of enhancement of radiation inactivation of cells is inferred. (T.F.H.)

30028 THE CANADIAN PROGRAM FOR THE IRRADIATION OF FOOD. A. B. Lillie and C. H. Hetherington (Atomic Energy of Canada, Ltd.). Proc. Japan Conf. Radioisotopes, 4th, 1054-63(1961). (In English)

The general objectives of the Commercial Products Division of the Atomic Energy of Canada Limited are stated and a review of the Canadian Food Irradiation Program is presented. The Canadian program consists of two main parts. The first part is a joint study of the effects of radiation on foods with several other government and industrial laboratories. The design and fabrication of irradiators and sources constitute the second part. (T.F.H.)

30029 RELATION BETWEEN RADIATION EFFECTS AND DOSE RATES IN RICE. Seiji Matsumura, Taro Fujii,

and Tomoo Mabuchi (National Inst. of Genetics). Proc. Japan Conf. Radioisotopes, 4th, 1064-8(1961). (In Japanese)

In order to investigate the relation of radiation effects to dose rates, dry seeds of upland rice are irradiated by γ rays from Co-60 or Cs-137 at doses of 5, 10, 20, and 30 kr and dose rates of 10, 300, and 10,000 r/hr. These chronic, moderate, and acute irradiations are terminated almost simultaneously before sowing. The germination rate, seedling height 19 days after sowing, seed fertility, and contents of free amino acids and reduced sugar are investigated. At 20 and 30 kr the germination rate is slightly lower, especially at chronic 20 kr and acute 30 kr irradiations, than those with 0, 5, and 10 kr irradiations. Unexpectedly, chronic irradiation applied from the start is most effective in inhibiting the growth of seedlings and in decreasing the fertility, especially at 20 kr. Thus an intensification of radiation damage due to storage is found. Contents of free amino acids and reduced sugar were examined in 5 grams of fresh leaves 19 days after sowing. (JAIF)

30030 EFFECTS OF GAMMA IRRADIATION UPON TULIP BULBS. Sohei Obata, Mitsuya Nezu, and Tadashi Katagishi (Toyama Agricultural Experiment Station). Proc. Japan Conf. Radioisotopes, 4th, 1068-70(1961). (In Japanese)

In order to obtain a bud mutation, irradiation of tulip bulbs is studied. Twenty-five varieties of tulips are γ-irradiated to 2 kr (13.2 r/hr), and plant height, anomalies in flower organs, and color changes in the first season are observed. (T.F.H.)

30031 MITIGATING EFFECT OF NITRATE AND POTASSIUM FERTILIZERS ON RADIOACTIVE CESIUM UPTAKE BY LOWLAND RICE. Kiyoshi Tensho, Ko-ling Yeh, Shigeru Yonezawa, and Shingo Mitsui (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 4th, 1115-17(1961). (In Japanese)

It is effective for mitigating the Cs-137 contamination of lowland rice to replace ammonium for top-dressing with nitrate and to use potassium simultaneously as top-dressing. In addition, it is shown that the cesium content of plant material largely depends on fertilization methods, such as the form of nitrogen, amount of potassium, and time of application. (T.F.H.)

30032 RADIOACTIVITY IN KOREAN FOODS. Tai-soon Kim and Tai-won Park (Ministry of National Defense, Republic of Korea). Proc. Japan Conf. Radioisotopes, 4th, 1118-22(1961). (In Japanese)

A survey conducted to determine contents of beta emitters, strontium-90, and cesium-137 in Korean foods is reported. The measurement of total beta activities in ashes of foods is carried out using G.M. tube. The specific activity of the foods under investigation ranges over 0.44 to 44 pC per gram of fresh sample. The chemical procedure for the determination of strontium-90 is based on the insolubility of strontium nitrate in fuming nitric acid. For the amount of cesium-137 the samples having higher water content (except milk) show lowest values, while the samples of high ash yield (for instance, Undaria pinnantifida, a sea weed, contains around 30 per cent of ash content) give higher values. (T.F.H.)

30033 THE EFFECT ON THE GERMINATION, RESPIRATION AND UREASE ACTIVITY IN SOYBEAN SEED WITH RADIATION BY Co-60. Sang-te Lee (Pusan National Univ.). Proc. Japan Conf. Radioisotopes, 4th, 1123-6(1961). (In Japanese)

There are many reports about the effect of x-ray and Ra-radioactivity to the plant seeds. OMURO studied on the effect of x-ray to the germination of rice and the growth of Broad bean. STOKLASA studied the effect of Pa-radioactivity to the germination of Broad bean and Green pea. The effect of radiation by Co-60 on the germination, respiration, and urease activity of soy-bean seed is studied at room temperature. (T.F.H.)

30034 DIFFUSION OF Cs-137 AND Sr-90 IN SOILS. T. M. Lai, T. C. Juang, and C. H. Chang (Taiwan Sugar Experiment Station, China). Proc. Japan Conf. Radioisotopes, 4th, 1127-35(1961). (In English)

A simple procedure for measuring diffusion of Cs-137 or Sr-90 in soils was used by depositing a very thin film of high specific activity tracer on the surface of samples. Soil moisture contents were maintained at controlled conditions by the use of a pressure plate extractor. Thin sections of sample were cut off and radioactivity measurements were made on the surface of the portion remaining after each cutting. The experimental method applied was tested to fulfill the boundary conditions of the law for instantaneous sources. Based on the exponential absorption law and through mathematical manipulations, the diffusion coefficients of Cs-137 and Sr-90 in soils were evaluated by a graphical method from the solution of the boundary conditions. Diffusion of Sr-90 in various kinds of soil in Taiwan was observed. However, movement of Cs-137 in some soils was too slow to determine its diffusion coefficients. Soil clays, bentonite, illite, and kaolinite were also used as diffusion media for these two radioactive ions, for the purpose of studies on the comparison between clay fractions and clay minerals as diffusion of tracer concerned. Diffusion of these two bracers in electrodialyzed sodium-, potassium-, and calcium-ion-saturated samples were also studied. From the experimental results, structure of clay minerals, clay contents, species of exchangeable cations, and moisture contents were concluded to be the factors affecting the diffusion of Cs-137 and Sr-90 in soils. (JAIF)

30035 STUDIES IN MANUFACTURE OF LABELED FERTILIZER. Komin Osada, Onkichiro Sato, Tohru Hirayama, Tasuku Suwa, and Kazuyoshi Hamada (Showa Denko K.K.). Proc. Japan Conf. Radioisotopes, 4th, 1150-5(1961). (In Japanese)

Labeled fertilizer has been utilized by a large number of researchers as an effective tool in making tests of fertilizer effect. Request for a wide variety of such labeled material and demand for the currently available types are expected to grow in the future. A special hood is set up, with a view to studying the manufacture of labeled fertilizer. The processes and conditions of developing labeled material having the desired composition and specific activity are reviewed. Work is also conducted on the structure and material of various types of manufacturing equipment and the measures to be taken against radiation hazard. Data are obtained for quantity production. (JAIF)

30036 STUDY ON THE UTILIZATION OF ACTIVATION ANALYSIS BY REACTOR NEUTRONS IN THE ANALYSIS OF MICROINORGANIC ELEMENTS IN PLANTS AND SOIL. Masao Shibuya (National Inst. of Agricultural Sciences, Tokyo). Proc. Japan Conf. Radioisotopes, 4th, 1156-60 (1961). (In Japanese)

A system of activation analysis is described that is completely nondestructive and requires no chemical separation. The system is able to analyze several minor elements in plants and soil. The combinations of neutron-irradiating

time, cooling time, and gamma spectrometry by multichannel analyzer were analyzed. (T.F.H.)

30037 PROCEEDINGS OF THE 5TH JAPAN CONFERENCE ON RADIOISOTOPES, [MAY 21-23, 1963, TOKYO, JAPAN]. NO. 2. SPECIAL SESSION. (Japan Atomic Industrial Forum, Inc., Tokyo). 1963. 159p.

Twenty-one papers are included; separate abstracts have been prepared for twenty. (H.M.G.)

30038 RECENT DEVELOPMENTS IN NEUTRON ACTIVATION ANALYSIS IN JAPAN. Tashio Nakai (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 1-13(1963). (In English)

The entrance into normal service in 1958 of the first reactor in Japan, the JRR-1 at the Tokai Research Establishment of the Japan Atomic Energy Research Institute, was followed by rapid progress in developmental studies in Japan in neutron activation analysis, mainly with the use of thermal neutrons. Applications are being developed, especially those that bring out the particular merits of this method, such as high sensitivity and high selectivity, which make it extremely attractive as a tool for microanalysis. Uses have now extended to a wide field of applications including metallurgy, geochemistry, petrochemistry, biochemistry, biology, medicine, agriculture, hydrology, and archeology. Non-destructive activation analysis utilizing the nuclear characteristics of short-life isotopes has found unique applications in the examination of precious and irreplaceable specimens such as in archeological work. Techniques of simplified and rapid analysis are also being established for dealing with large numbers of samples successively on a routine basis. Other developments mentioned in activation analysis include work utilizing fast neutrons (14 Mev) from neutron generators, and charged particles from accelerating machines such as cyclotrons. This opens up new possibilities in the analysis of light elements, difficult to determine with thermal neutron. (JAIF)

30039 FUNDAMENTAL ASPECTS OF RELATIVE BIOLOGICAL EFFECTIVENESS. Sohei Kondo (National Inst. of Genetics, Misima, Japan). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 14-21(1963). (In English)

Fundamental aspects of the absorbed dose required to produce a given biology effect are discussed in relation to the dependence of relative biological effectiveness (RBE) upon spatial distribution of primary physical products. Representative curves of RBE versus linear energy transfer (LET) for somatic and genetic effects in higher forms and microorganisms have been summarized from published experimental results and their fundamental meanings have been discussed at the molecular level by the generalized target theory based on the hypothesis that the radiation sensitive target is made of multi-subunits. The RBE-versus-LET curves for somatic damages in the intermediate LET region can be accounted for by assuming that the target is made up of subunits and that overall damage is caused by the occurrence of one or more primary ionizations in each subunit. The proposed structure of the target is in good agreement with electron microscopic observation of chromosomes. Thus, it has been concluded that in most cases radiobiological effects are due to chromosome structural damages and that in general the shape of RBE-versus-LET curve is reflection of the nature of primary lesions of radiation damages under consideration and the complexity of the target which can be expressed in terms of subunit diameter and the subunit number per target. However, discrepancy between the theory and experiments is very large in the low LET region and factors responsible for it have been briefly discussed. It has been pointed out that radiobiological processes are simpler for high to intermediate than low LET radiations. RBE has been also discussed briefly from the standpoint of radiation hazards to man. (JAIF)

30040 PRODUCTION OF RADIOISOTOPES WITH VERY HIGH SPECIFIC RADIOACTIVITY. A. F. Rupp (Oak Ridge National Lab., Tenn.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 22-9(1963). (In English)

Methods of producing chemically and isotopically pure radioisotopes are considered briefly with main emphasis being placed on examination of the many important radioisotopes that can be produced in sizable quantities only by neutron-gamma reactions or that normally occur as fission products contaminated with other isotopes of the same chemical species. Approaches to the problem of increasing specific activity of such radioisotopes are identified. Irradiation techniques to be used for radioisotope production in an ultra-high-flux reactor near completion at Oak Ridge National Laboratory are described. (H.M.G.)

30041 RECOIL CHEMISTRY AND ITS APPLICATION. Nobufusa Saito (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 30-7(1963). (In English)

Recent Japanese work in the field of recoil chemistry falls into two categories: study on the enrichment of recoil atoms by the Szilard-Chalmers process and study on the nature of recoil reactions. The present review summarizes the results of the Japanese investigations in this field that appeared during the past several years. Some emphasis is placed on inorganic recoil chemistry most extensively studied at several laboratories. (JAIF)

30042 SOME RECENT TOPICS ON THE FRONTIER OF CHEMISTRY BASED ON RESEARCH REACTORS. Reinosuke Hara (International Atomic Energy Agency). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 38-44(1963). (In English)

Chemistry has been playing an important role in research programs based on research reactors. A research reactor serves for chemistry areas either as a tool for services, as illustrated in isotope production and activation analysis, or as a tool for advanced research. Some of the recent topics in advanced chemistry research based on research reactors, which include nuclear chemistry, hot atom chemistry, and radiation chemistry, are reviewed. (JAIF)

30043 THE ACTIVITIES OF THE ATOMIC ENERGY COMMISSION IN THE FIELD OF THE INDUSTRIAL APPLICATIONS OF RADIOISOTOPES. M. Cornuet (Centre d'Etudes Nucleaires, Grenoble). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 45-9(1963). (In English)

The Atomic Energy Commission of France in 1951 created the Section for the Application of Radioisotopes (S.A.R.) for the purpose of studying extensions of nuclear science in research and industry. Organization, programs, and future prospects of the S.A.R. are reviewed. (H.M.G.)

30044 PARTICLE ACCELERATORS IN INDUSTRY. Hiroshi Kamogawa (Tokyo Shibaura Electric Co. Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 50-6(1963). (In English)

Characteristics of particle accelerators applicable for use in medicine and industry are identified. Recently obtained features of their industrial applications are discussed. (H.M.G.)

30045 RECENT TECHNICAL PROGRESS IN INDUSTRIAL APPLICATIONS OF RADIOISOTOPES AS A SEALED RADIATION SOURCE. Hirohide Miwa (Kobe Kogyo Corp., Japan). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 57-64 (1963). (In English)

New techniques for Fail-Safe and Self-Checking radiation relays used in industry and for railway traffic systems and for composition and thickness gaging of metals were devised by the Japanese. Several improvements incorporating utilization of sealed radiation sources are described. (H.M.G.)

30046 RADIOLYSIS OF LIQUID AMMONIA. L. G. Carpenter and D. E. Deutsch (Aerojet-General Nucleonics, San Ramon, Calif.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 65-71(1963). (In English)

Aerojet-General Nucleonics studied the fission fragment radiolysis of liquid ammonia as part of an Air Force program to build a pumped-slurry, reactor loop for hydrazine production. Gas chromatography, absorption spectroscopy and micro-current coulometry are used for chemical analysis, and solid state fission fragment detectors are used for irradiation dosimetry. The radiolysis products of liquid ammonia appear to be limited to hydrazine, hydrogen and nitrogen. There is no formation of nitrate, nitrite, hydroxylamine or azides unless the ammonia is impure. The relatively low product yields from gamma and x-ray experiments were interpreted by simple reactions involving H and NH_2 radicals and N_2H_4 molecules. Much higher yields of hydrazine, as well as hydrogen and nitrogen, have been observed in fission fragment experiments. These cannot be adequately explained by the gamma ray mechanism alone. The higher concentrations of H and NH_2 radicals along the fission fragment tracks would produce higher relative yields of hydrogen and hydrazine, but the higher yields of nitrogen and generally greater effectiveness of fission fragments require different mechanisms. These may involve NH radicals or excited NH_2 radicals. Several methods, such as photochemical production of specific radicals in frozen ammonia and tracer experiments with N^{15} labeled hydrazine, are under study to test the proposed mechanisms. (JAIF)

30047 GRAFT COPOLYMER STUDIES ON MYLAR AND NYLON. D. S. Ballantine and A. Glines (Brookhaven National Lab., Upton, N. Y.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 72-7(1963). (In English)

A study was made of the graft copolymerization of mylar and nylon with styrene monomer, using both a simultaneous irradiation and a preirradiation technique. The variables studied were the effect of solvents, irradiation temperature, and grafting temperature. In addition to determining the grafting rates, an attempt was made to determine the chain length of the grafted-on polystyrene. The copolymers were hydrolyzed and a determination made of the molecular weight of the polystyrene residue. The grafted-on polystyrene affects the ability to hydrolyze the parent polymer. It was also found that the solvent and irradiation affect the rate of grafting and the chain length of the polystyrene in the copolymer. (JAIF)

30048 THE BNL RADIATION PROCESSING RESEARCH PROGRAM. Meyer Steinberg and Bernard Manowitz (Brookhaven National Lab., Upton, N. Y.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 78-88(1963). (In English)

A research, development, and evaluation effort on the use of nuclear energy for the production of chemicals has been established in the Radiation Division of the Nuclear Engineering Department at Brookhaven National Laboratory. This radiation processing program is divided into two main areas. One is concerned with the use of nuclear fission reactors as radiation sources for chemical processing and has been termed the "chemonuclear" reactor program. The other is concerned mainly with the use of isotopes for chemical processing purposes. The chemonuclear reactor radiation is generally indicated for endothermic reactions, involving a net conversion of nuclear to chemical energy, while the isotopic radiation is indicated for exothermic reactors. In the latter case, isotopic radiation becomes economically attractive only for high G value exothermic chain reactions. Experimental work done under the radiation processing program is reviewed. (H.M.G.)

30049 GRAFT COPOLYMERIZATION INDUCED BY RADIATION. Ichiro Sakurada (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 89-94(1963). (In English)

Graft copolymerization of methylmethacrylate (MMA) onto polyvinyl alcohol (PVA) film was carried out using a pre-irradiation technique with Co^{60}. Raw copolymer was obtained with 96.1% graft, which was acetylated and dissolved in benzene. Fractionation of the copolymer acetate was performed using n-butanol as a precipitant. The composition analysis and viscosity measurements were undertaken for each fraction. By saponification of each fraction, the backbone was converted back into PVA, and the PVA chain was cleaved with periodic acid. Viscosities of the acetates were compared before and after cleaving. The results indicate that, though the apparent percent graft copolymer is high, 96% of backbone polymer was not grafted, and all graft copolymers have one branch in one PVA molecule. (JAIF)

30050 GENETIC VALUE OF ESTIMATION OF THYROXINE SECRETION RATE. Charles W. Turner (Univ. of Missouri, Columbia). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 95-104(1963). (In English)

A method of estimating the thyroxine secretion rate (TSR) of domestic and laboratory animals was developed using I^{131} as a tracer. It is based on the injection of I^{131}, measurement of thyroidal-I^{131}, blockage of recycling of I^{131} with a goitrogen, and then blocking the release of thyroidal-I^{131} with increasing administration. The estimated TSR is the minimal amount of thyroxine required to inhibit thyrotropin secretion and thyroidal-I^{131} release. The wide variation in TSR of individual animals is considered of great significance. Under uniform environmental conditions these differences are suggested to be genetically determined. Since thyroxine plays an important role in reproduction, growth, and lactation, animals in which TSR is above average, yet within the normal range, the TSR would be expected to grow more rapidly and lactate at higher levels. It is suggested further that selection of breeding animals based upon their TSR will result in progeny of higher productive potential. Studies were made which indicate the role of environment in influencing TSR and those reproductive processes influenced by thyroxine. Experiments indicating the role of thyroxine in influencing the growth of the mammary glands of rats and the intensity of milk secretion are reported. (H.M.G.)

30051 RECENT ADVANCES IN THE DIAGNOSIS OF RENAL HYPERTENSION WITH RADIOISOTOPE PROCEDURES. G. V. Tamplin, E. K. Dore, and D. E. Johnson (Univ. of California, Los Angeles). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 105-16(1963). (In English)

Progress during the past three years in the development

of diagnostic tracer techniques for investigating renal disease is reviewed. Kidney characteristics, urine passage through the kidneys, and renal blood flow may be studied with radioisotopes such as Hippuran I^{131}. Advantages of tracer and photoscanning techniques in renal studies are identified. (H.M.G.)

30052 BIOCHEMICAL APPLICATIONS OF NEUTRON ACTIVATION CHROMATOGRAPHIC ANALYSIS. A. A. Benson (Univ. of California, San Diego), W. W. Miller, and Joseph M. Steim. Proc. Japan Conf. Radioisotopes, 5th, No. 2, 119-26(1963). (In English)

The processes of paper chromatography and neutron activation analysis were combined to obtain quantitative and qualitative analyses of organic compounds and certain inorganic ions. The substances analyzed were separated by paper chromatography (for qualitative analysis) and then activated in a neutron flux (for quantitative analysis). Compounds without activable atoms were assayed by conversion to bromine derivatives or other atoms with suitable neutron capture cross sections. Application of neutron activation chromatography for phospholipid and sugar phosphate is reviewed. (H.M.G.)

30053 RECENT DEVELOPMENTS IN RADIATION PASTEURIZATION OF FOODS IN THE UNITED STATES. B. S. Schweigert (Michigan State Univ., East Lansing). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 127-31(1963). (In English)

Irradiation pasteurization or use of low levels of irradiation to extend the shelf life of foods by controlling microbial growth is discussed. Techniques of irradiation and packaging, criteria for irradiated foods, and advantages of radiation pasteurization are reviewed. Major centers in the United States conducting research on irradiation pasteurization are identified as to type of research being done. (H.M.G.)

30054 RESULTS OF THE CANADIAN POTATO IRRADIATION PROGRAM. C. H. Hetherington and K. F. MacQueen (Atomic Energy of Canada Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 132-4(1963). (In English)

Results of test irradiations of potatoes in Canada between October 1961 and March 1962 are reviewed. Completely effective sprout inhibition was obtained in all cases. Radiation treatment was observed to be more effective than other methods. A lower dosage level would probably be satisfactory on a commercial basis. There was no internal sprouting and irradiated potatoes remained firmer than controls. Some dry rot was present in both control and treated potatoes. Irradiated potatoes were found to be more resistant to light greening. The quality of chips, instant mashed potatoes, frozen French fries, and fresh boilers produced from irradiated potatoes was found to be good. Implications and plans for commercialization of the process are discussed. (H.M.G.)

30055 STUDIES ON THE EFFECTS OF RADIATION ON RICE, WHEAT, AND BARLEY. Teng-Ying Ouang (Taiwan Provincial Chung-hsing Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 142-7(1963). (In English)

Four varieties of rice, three varieties of wheat, and three of barley were treated by x-ray, gamma ray, and thermal neutrons. Two different dosages of each type of radiation were applied. The irradiated materials obtained were tested for germination, habit of growth, chromosomal aberration and the induced mutants. A linear inhibiting effect on the germination of seeds was shown. Generally, during the initial germinating stages, growth of the irradiated seed was slower than that of the control. This fact supports the concept of Bora et al. The growth of irradiated plots in the field, with a few exceptions, was inferior to the nonirradiated plot, especially on high dosage. The tillers of rice, wheat and barley were distinctly increased in the irradiated plots. Chromosomal aberrations were observed to increase with increasing dosage, agreeing with the report of Larose. Wheat showed to have the highest grade of variation, barley next, and rice the least. The chromosomal aberrations on various crops were generally alike. They were changes of numbers and change of structure. Univalent changes of number were predominant. Many of the mutants considered highly valuable are examined and saved for advanced breeding material. (H.M.G.)

30056 THE INTERNATIONAL ATOMIC ENERGY AGENCY'S COORDINATED RESEARCH PROGRAM ON ISOTOPE TECHNIQUES IN RICE CULTIVATION. Maurice Fried and Hans Broeshart. Proc. Japan Conf. Radioisotopes, 5th, No. 2, 148-53(1963). (In English)

The inception of a coordinated contract research program sponsored by the International Atomic Energy Agency (IAEA) is described. The program on the application of isotope techniques to rice cultivation serves as a typical example of the activities of the IAEA Unit of Agriculture in southeast Asia. Studies of fertilizer use in rice cultivation employing labeled superphosphate are reviewed. (H.M.G.)

30057 RADIOBIOCHEMICAL STUDIES ON RIPENING PROCESS OF RICE PLANT. Zenzaburo Kasai and Kozi Asada (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 2, 154-8(1963). (In English)

The grain formation mechanism and the origin of various grain components were studied by means of radioisotope application to rice plants at different stages of growth. By application of radioisotopes to rice plant at each stage of its growth, it was determined at what growth stage the nutrients found in the grains at the end of maturing had been absorbed. The carbon, calcium and strontium have their origins chiefly in those nutrients absorbed after the flowering. On the other hand, the phosphorus absorbed before the flowering is the main source of that of the grains. Because the vigorous accumulation of phosphorus into the grains from the other parts is observed, the metabolic fate of phosphorus thus accumulated in the grains was investigated. At the end of maturing, over 80% of the total phosphorus of the grains was found as phytin, as a final product of phosphorus metabolism. A metabolic pattern of phosphorus in the rice grains is proposed and a possible function of inositol in the accumulation of phosphorus, in connection with the formation of starch, is discussed. (H.M.G.)

30058 PROCEEDINGS OF THE 5TH JAPAN CONFERENCE ON RADIOISOTOPES, [MAY 21–23, 1963, TOKYO, JAPAN]. NO. 3. BASIC RESEARCH AND COMMON TECHNIQUES. (Japan Atomic Industrial Forum, Inc., Tokyo). 1963. 309p.

One hundred papers are included; separate abstracts have been prepared for ninety nine. One paper was previously abstracted in NSA. (A.G.W.)

30059 RADIUM THERAPY FACILITIES IN NATIONAL CANCER CENTER HOSPITAL. Yoichiro Umegaki, Masahiko Hamada, Takeshi Utsunomiya, and Kenji Yoshii (National Cancer Center Hospital and Kimura Entetsu Co. Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 1-3 (1963). (In Japanese)

In the design of the Ra therapy section at National Cancer Center Hospital, special attention was given to minimizing

unnecessary exposure to radiation. The principal facilities are as follows: (1) a 2-curie automatic rotating Ra safe containing small sources of Ra and Co^{60}; (2) a 1-curie hand-driven rotating Ra safe containing loaded applicators; (3) manipulators for remote handling of sources; (4) a series of sinks, sterilizer, dryer, and manipulating table shielded with lead barriers; (5) an Oak Ridge-type fume hood for preparation of liquid sources. Reasons for adopting the rotating type Ra safe are listed. Exposure of physicians and nurses was controlled satisfactorily during radiation treatment of about 200 cases in the past eight months. (A.G.W.)

30060 DESIGN OF A CELL FOR MEASUREMENT OF RADIOACTIVITY. Tamaki Watanabe (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 3-6(1963). (In Japanese)

A new type of cell for measurement of the concentration of radioactive solutions was designed, constructed, and used for routine measurement of the concentration of radioisotope products prepared at Japan Atomic Energy Research Institute. Both volumes and radioactivities of the solutions are measured in it. The cell is divided into two parts: one for operating radioactive solutions of pure beta emitters and the other for gamma emitters. Each side is plated with 5 cm of lead. Radioactive materials in the cell are handled by two ball socket manipulators and special tongs. In order to observe inside the cell, a lead glass window 20 × 20 × 10 cm is used for the gamma part and an organic glass plate 1 cm thick for the beta part. An operation table is set in the middle of the cell. Radiation detectors, mechanisms of special tongs, and drawer guides are under this table. For inserting radioactive materials into the cell, a container with a lead drawer is used. Thus, the operation area in the cell is made wider. The dose rates at the outer surface of the cell do not exceed 10 mr/hr, provided the following quantities of radioisotopes are individually handled: for example, 27 mC for Na^{24}, 100 mC for Co^{60}, 44 C for I^{131}, and 350 C for Au^{198}. (JAIF)

30061 ON JAERI'S HOT LABORATORY BASED ON ITS OPERATING EXPERIENCE. NO. I. M. Murakami, Y. Sumiya, Y. Sasaki, T. Otuka, H. Hagiya, and A. Sirasaki (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 7-9(1963). (In Japanese)

The High Activity Handling Building is a general purpose handling facility and has been in operation since September 1961. The facility is concerned with a wide variety of metallurgical study, such as capsule disassembling, mechanical tests of irradiated materials, metallography, and any other high-activity handling requirements that may arise. The experience gained in the operation of these facilities from September 1961 to January 1963 is described. The equipment, operational difficulties, and decontamination are discussed in relation to safe handling of high-activity materials. (JAIF)

30062 ON JAERI'S HOT LABORATORY BASED ON ITS OPERATING EXPERIENCE. NO. II. Masatoshi Murakami, Tokutaro Matumoto, Hisanori Ito, and Kyoichi Abe (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 10-12(1963). (In Japanese)

The following aspects of the dissolving of irradiated UO_2 and the separation of Pu from the solution are described: method and installation of experiment, system of work, circumstance of contamination and method of decontamination, and handling of high-level radioactive waste. (A.G.W.)

30063 ON THE DESIGN AND CONSTRUCTION OF A HOT CELL. Hikaru Shimojima, Akira Tani, and Yoji Shimizu (Nippon Atomic Industry Group Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 13-15(1963). (In Japanese).

A cell for handling radioisotopes was designed and constructed at Nippon Atomic Industry Group Nuclear Research Laboratory. The cell is a simple shielded cubicle with an interior 3 m high, 4 m long, 2 m wide, and surrounded by 1 m thick ordinary concrete. The cell interior is lined with steel plate and coated with paint and polyester resin. The cell is divided into two parts: one half is equipped with remotely controlled capsule openers to receive and arrange radioisotopes; the other half is equipped with water, gas, and electricity supply and is capable of chemical experiments. Remote-control equipment, storage holes under and behind the cell, access for personnel and equipment, the service room, illumination, ventilation, and waste disposal are described briefly. (A.G.W.)

30064 LEAKAGE TEST OF HOT CELLS, NAIG RESEARCH LABORATORY. Toshio Miyake (Nippon Atomic Industry Group Co., Ltd.) and Chyuichi Tuzuki. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 16-18(1963). (In Japanese)

NAIG Nuclear Research Laboratory is provided with two types of hot cell, one of which is used for gamma-ray irradiation and the other for radiochemical researches. The housing capacities of them were estimated by calculation and determined by measuring leakage doses after the construction. The scattered gamma ray through the labyrinth of the gamma-irradiation cell containing 3000 curies of Co^{60} was measured with a pulse height analyzer. The leakage dose at the door was over the admissible value so an additional shield was elected. It was ascertained that the radiochemical cell is capable of being used for handling up to 50 curies of Co^{60}, in spite of its large opening (38 cm × 100 cm × 3300 cm) in the front face of the shielding wall. (JAIF)

30065 A RI LAB. OF NTT AND THE EXAMINED RESULTS OF EXHAUST AND LIQUID WASTE DISPOSAL FACILITIES. IBARAKI ANNEX OF ECL. Shozo Hagai, Soichiro Okishio, and Tatsuo Murakami (Ibaraki Annex, Electrical Communication Lab.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 19-21(1963). (In Japanese)

In 1962 a radioisotope laboratory was constructed at Ibaraki Annex by the Electrical Communication Laboratory, Nippon Telegraph and Telephone Public Corporation. The main building is of steel concrete and occupies 993 m^2. Radioisotope hoods for radiochemical and radiometallurgical work and storage for radioactive materials are provided. The ventilation system and liquid waste disposal facilities are described briefly. Tests showed that the elimination coefficient of I^{128} in exhaust line A was 99.9% and the collection coefficient of Mn^{56} in liquid waste disposal line A was 91.4%. (A.G.W.)

30066 SHIELDING OF GAMMA-RAYS BACKSCATTERED FROM DIFFERENT TYPES OF CONCRETE WALL. Seiichi Fujii, Takashi Sekine, and Kazuo Ito (Building Research Inst., Ministry of Construction). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 22-4(1963). (In Japanese)

An attempt was made to give the fundamental data for the shielding of scattered γ rays, which might be useful to the shielding design of the radiation room. Radiation sources were Co^{60} (0.25C) and Cs^{137} (1C). The detector was a pulse-height analyzer with NaI(Tl) scintillator. To

detect the intensity of the scattered radiation, an ionization chamber was used. Concrete walls 10 cm thick, containing many kinds of aggregates such as magnetite, limonite, hematite, and others were placed on a table and exposed to gamma-rays. The diameter of the radiation field was 30 cm on the surface of the wall. The scattering angle θ, defined from the axis of incident and scattered gamma-ray beams, covered values 75°, 90°, 105°, 120°, 135°, and 150° Lead plates were used to attenuate gamma-rays back-scattered from concrete walls, and the results were presented in figures showing the relation between attenuation factor and thickness of the lead plate. The attenuation factor is denoted in the form of 1000 BsDs/Du, where Bs, Ds, and Du are the fractional transmission of the lead plate, the unattenuated dose in the scattered beam at 1 m from the scatterer, and the dose incident on the scatterer. (JAIF)

30067 ON THE PHYSICAL AND CHEMICAL PRE-USE TESTS OF SEALED SOURCES. H. Yamashita, et al (Japan Radioisotope Assn.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 25-7(1963). (In Japanese)

An attempt was made to establish the standards of safe handling of sealed radioactive sources and to find the most efficient and practical method of contamination and spillage detection through various experiments with several α-, β-, γ-ray sealed sources used most commonly. The sources used are as follows: Ra cells and needles of Belgium, Co^{60} γ-ray sources of RCC, Co^{60} γ-ray radiographic sources of Japan Radioisotope Association, Sr^{90} β-ray sources by RCC, and Po^{210} α-ray sources of RCC. Testing items are as follows: (a) higher (up to 8 atm) and lower atmospheric compressing tests; (b) static compressing tests (up to 2 gross-tons) and shock tests (up to 4.5 kg-m); (c) heating tests (up to 900°C); (d) water soaking tests; (e) chemical soaking test. Spillage detection tests such as boiling, liquid soaking, gas soaking, and vacuum tests were also conducted. Comparison of the results led to an efficient and practical method of spillage detection. (A.G.W.)

30068 EXPERIMENTAL STUDY ON FIRE RESISTIVITY OF RADIOISOTOPE CONTAINERS AND CAPSULES. T. Moriya (Fire Research Inst. of Japan), T. Jin, and S. Horiuchi. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 28-30(1963). (In Japanese)

Several tests for the evaluation of fire-resistive performances of radioisotope containers and capsules were performed in connection with an experimental fire in a fire-resistive building. Other tests for the same purpose were performed in the laboratory using electric furnaces to produce the same heating conditions as fires. Containers tested were of three types, all of them cylindrical in shape. The rise of temperature produced in one of the containers during the test was measured. It is concluded that the container No. 1, made of lead for the most part and coated with 5-mm iron plate on its whole surface, may be resistive to fires generally. But it can not be concluded that the above-mentioned fact will hold for all cases of fires. The container No. 2, wholly made of lead, and the container No. 3, made of lead with only the side surface coated with iron, are not resistive to any fires, because they may be melted away by heat. The double capsule, which consists of an inner capsule and an outer capsule made of stainless-steel, may be fire-proof for most of fires. But if some iron or aluminum is contained in the capsule as spacers, the stainless steel in contact with aluminum or iron of the spacers begins to melt gradually while the capsule is being heated, making a hole through the capsule in some cases. (JAIF)

30069 PENETRATION OF GAMMA RAYS FROM PLANE ISOTROPIC SOURCES. Akira Tsuruo (Japan Atomic Energy Research Inst.) and Tayoru Toyota. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 31-3(1963). (In Japanese)

The experimental results of penetration of gamma rays from plane distributed isotropic sources are described. The results are obtained by using point sources and a long ionization chamber located at the opposite side of the shield materials. The sources used are Au^{198} (0.412 Mev), Cs^{137} (0.662 Mev), Co^{60} (1.17 Mev and 1.33 Mev), and Na^{24} (1.37 Mev and 2.75 Mev). The long ionization chamber is 55 cm long and 3 cm in diameter. Shield materials for the experiment are aluminum, iron, and lead whose thicknesses are selected up to 8 mean free paths. Gamma rays that penetrate the shield materials are measured at several points on the surface by the ionization chamber whose axis is horizontal and parallel to the plane of them. The dose distribution obtained by the above experiment can be used to calculate the gamma-ray dose at a point in the case of 60 cm × 55 cm plane isotropic sources by integrating the above results. Dose distribution curves are extrapolated to get results of infinite plane isotropic sources. On the same geometry, the penetration of gamma rays is calculated without the consideration of scattering, and dose build-up factors are obtained by the comparison of the calculated values with the experimental ones. (JAIF)

30070 Co-60 CONFORMATION RADIOTHERAPY UNIT. Makoto Watanabe (Nagoya Tetsudo Hospital), Nobuo Ono, Katsumi Nagai, and Fumiharu Nezu. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 34-6(1963). (In Japanese)

A new collimating shutter device was developed by use of which rotary radiation fields can be adjusted to all kinds of tumor shapes. In order to change the shape of the diaphragm aperture, the diaphragm is divided into several blocks and each block is operated by cams. To change the radiation field with the rotation, a cam shaft that actuates the diaphragm blocks is devised to rotate in synchronization with the rotation of the radiation container. Several kinds of cams are provided for different shapes of tumors. The device can be used for fixed radiation by fixing the diaphragm aperture. The maximum dimension of the radiation field is 15 cm^2 on the center of rotation. (A.G.W.)

30071 ON THE QUANTITY OF RADIOISOTOPES IN LIQUID WASTE AND SOME PROBLEMS WITH REGARD TO THE STORAGE TANK OF LOW LEVEL WATER. S. Fujii, T. Sekine, and K. Ito (Building Research Inst., Ministry of Construction). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 37-9(1963). (In Japanese)

Some problems on the design of drains for the liquid chemical waste from the radioisotope laboratories were investigated. The amount of radioisotopes released in the low-level liquid waste was measured in some typical radiochemical treatments. Radioisotopes used in the experiments were P^{32}, I^{131}, and S^{35}. This percentage was found to be approximately 1–10% for these typical treatments, and in the case of low level treatments this percentage became higher. An underground tank made of concrete is commonly used to store the low level liquid water. To examine the leakage of the water through the wall of the tank, two concrete tanks, 1m × 1m × 1m, with wall thickness 10 cm were used. One was plain and not lined, but the other was lined with epoxy-resin paint on the inner surface. These tanks were filled with water containing P^{32} and I^{131} respectively, and the leakage from the concrete wall was checked from time to time. Two months after the

experiment started, the amount of the isotope absorbed in the concrete wall was examined. In the first tank, activity on the outside surface of the wall did not exist. However, examination of the concrete showed the activity reached almost to the outer surface penetrating the 10 cm wall. On the other hand, the second tank had no leakage. It was concluded that tanks for storing liquid waste higher than MPC should be lined by some material such as a plastic paint or coating. (A.G.W.)

30072 STUDY ON THE DEWATERING TREATMENT OF RADIOACTIVE SLUDGES. Tetsuo Mamuro, Takashi Matsumura, and Toshio Ishiyama (Radiation Center, Osaka Prefecture). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 49-2(1963). (In Japanese)

The methods that have been applied for dewatering radioactive sludges are the following four or their combinations: settling, filtration, centrifuging, and freezing. The effect of addition of several kinds of polymers on the dewatering efficiency was investigated for each method except centrifuging. Three kinds of sludges—bentonite-Konan Floc sludge, calcium phosphate sludge, and ferric hydroxide sludge—were tested. The most effective dewatering method for each kind of sludge was found as follows: for Bentonite-Konan Floc sludge, vacuum filtration after freezing at −2°C, with 100 ppm polyoxyethylene added; for calcium phosphate sludge, vacuum filtration after freezing at −2°C, with 300 ppm Separan AP 30 added; and for ferric hydroxide sludge, vacuum filtration after freezing at −13°C, without polymer addition. Although the vacuum filtration after freezing and thawing is considered to be the most effective method as described above, handling of the sludge cake formed in a filter is troublesome. For this reason, the settling treatment after freezing and thawing has been adopted at our laboratory because the amount of radioactive sludges is sufficient at the present time. A small radioactive sludge concentrator was constructed at the Radiation Center of Osaka Prefecture in March of 1962. This plant is the first attempt in Japan to adopt the freezing treatment for concentrating the radioactive sludge. The effective capacity of treatment is 100 liters per day. The time required for one cycle operation is usually about 12 hours, 6 hours of freezing and 6 hours of thawing. The over-all volume reduction ratio is at least 20. (A.G.W.)

30073 STORAGE TANKS PACKED WITH ION-EXCHANGERS FOR TREATMENT OF RADIOACTIVE WASTES. Shigehisa Iwai and Yoriteru Inoue (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 43-5(1963). (In Japanese)

A new method which increases the detention times of radioisotopes in a holding tank by packing ion-exchange materials in it is presented. The detention time of a radioisotope in the holding tank packed with ion exchangers can be expressed as $t' = \{f + (1 - f)\rho k_d\}t = \{f + (1 - f)\rho k_d\} \cdot (V/Q)$ where t' is the detention time of a specific radioisotope in a holding tank with exchanger, t is the detention time of a holding tank without exchanger, f is the porosity of the ion exchanger in the tank, ρ is the density of the ion exchanger, k_d is the distribution factor of the specific isotope, V is the volume of the tank, and Q is the flow rate of wastes. When synthetic ion-exchange resin is packed in the holding tank, detention time for radiostrontium in a waste having chemical components similar to tap water is 1000 times the detention time of the tank without exchangers. This method does not need re-pack of exchanger after its use so it will not be costly compared with the conventional holding method. (A.G.W.)

30074 REMOVAL OF Sr-90 ON NIIGATA MONTMORILLONITE CLAY BY COLUMN TECHNIQUE. Masao Takizawa (Inst. of Physical and Chemical Research), Kugao Koda, Shigetane Uehara, and Akio Hirokawa. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 46-8(1963). (In Japanese)

Natural clay in rods of 1 mm dia × 2-5 mm was prepared from a predominantly Ca saturated montmorillonite, a commercial bleaching earth from Omi, Niigata prefecture, by mixing with polyvinyl acetate as a binder and drying the resulting paste in rods at 110°C. Portions of the natural clay in rods were converted to Na and H forms by treating with 1N solutions of the corresponding chloride, and the clays were washed with distilled water and dried at 110°C before using for Sr^{90} removal. Through a column (20 mm dia) containing 20 g of clay in rods, each of the solutions containing Sr^{90} was percolated at a flow rate of 10 ml/min at room temperature. Effects of Na and Ca ions on the efficiency of Na clay for Sr^{90} removal from pH 6.5 solution containing 10^{-2} μC/ml Sr^{90} are expressed by experimental equations. A pH range of 6.4 to 9.2 was found to be preferable for Sr^{90} removal on Na clay. The decontamination factor for Sr^{90} by Na clay decreased with increasing strontium concentration. In the presence of 5×10^{-2}N $CaCl_2$ at pH 6.4, values of the factor were more than 100 for 3.5×10^{-2} μC/ml Sr^{90}, and ~30 for 5 ppm carrier traced with 3.2×10^{-2} μC/ml Sr^{90}. Na clay was found to be incomparably superior in efficiency of Sr^{90} removal to two clays, natural clay and H clay. (A.G.W.)

30075 ON THE SUSCEPTIBILITY AND DECONTAMINATION PROPERTIES OF SURFACE FINISHING MATERIALS. S. Fujii, T. Sekine, and K. Ito (Building Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 49-51 (1963). (In Japanese)

The smear method is compared with an ordinary method for the measurement of decontamination factors. The smear method provides the decontamination factor of loose contamination and generally gives better results compared with the ordinary method using the surface contamination detector. However, for the sake of convenience and accuracy, it is preferable to adopt the ordinary method. To improve the decontamination experiment, it was found that more serious attention should be paid to the following points: (1) time elapsed after the testing materials were contaminated; (2) chemical form of the contaminant, especially its pH; and (3) drying method of contaminant applied to the testing materials. The results of decontamination properties of twenty kinds of materials, most of them newly produced in Japan since 1958, are summarized. The decontamination reagents used are EDTA, $HNO_3 + H_3PO_4$, HI, and ferric ammonium citrate. Generally speaking, these newly produced materials are comparatively easily decontaminated by any kind of reagent. In this experiment, P^{32} and I^{131} were used as the contaminant for the most part. It was found that the susceptibility for the former is higher than the latter but, on the contrary, most of the decontamination reagents work better for P^{32} than I^{131}. This comes probably from the fact that P^{32} has a very low pH and is corrosive. (A.G.W.)

30076 THE PASTE FOR THE PURPOSE OF THE DECONTAMINATION. Yuzo Tajima (Japan Atomic Energy Research Inst.), Yoshiki Wadachi, Shingo Tashiro, Tetsuo Hiyama, and Yoshikatsu Tobita. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 52-4(1963). (In Japanese)

For surface decontamination, a paste is often better than a solution of reagents to prevent contamination from

spreading. The properties required for the paste are high stability, high decontamination ability, suitable stiffness on the contaminated surface, and low cost of waste disposal. Pastes of titanium dioxide, bentonite, and sodium alginate to which were added surface active agents and chelating agents were examined. Plates of plastic floor material were contaminated with F. P. in HNO^3 solution, about 22,000 cpm respectively. Then the plates were treated with pastes on the decontamination polishing test machine. The compositions of the best pastes for surface decontamination are shown. The relation of the decontamination abilities of the three best pastes to the pH of the contaminant was examined. (A.G.W.)

30077 ON A RADIOISOTOPE-BURNING-ARRANGEMENT FOR STUDY OF RADIOACTIVE CONTAMINATION GENERATED BY FIRES. T. Moriya (Fire Research Inst.), T. Jin, and S. Horiuchi. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 55-6(1963). (In Japanese)

An arrangement was built to study experimentally the degree of radioactive contamination which may occur in and around a radioisotope institute when a fire breaks out in the area. The arrangement consists of a coal-gas burning chamber, a radioisotope-burning furnace, a water-shower-cooler, a filter box, and a turbofan. Radioisotopes can be burnt with combustible substances under conditions similar to a fire in the radioisotope-burning furnace of the arrangement. The ratio of the part of the active substance in the furnace that flows upward as gas to the part that remains as ash in the furnace can be determined by means of the burning experiment using the furnace. As it is supposed that the gas discharged from the furnace during combustion has considerable radioactivity, a special method was adopted to remove radioactive dusts and mists from the gas and to discharge them safely into the atmosphere. (JAIF)

30078 EFFECTS OF RADIATIONS ON BONE MARROW FUNCTION–RBE OF 200 kvp X-, 15 Mev X-, ^{60}Co γ-RAY. Masasi Fukuda, Yoshimasa Tanaka, and Masatomo Hashi (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 57-9(1963). (In Japanese)

Young male rats weighing about 150 g were irradiated over the whole body with 200-kvp x rays, Co^{60} γ rays, and 15-Mev x rays. To measure Fe^{59} uptake 1 μC of Fe^{59} citrate solution was injected into the femoral vein, and whole blood was drawn from another femoral vein at daily intervals. Radioactivity was measured in a well-type scintillation counter, and total red cell radioactivity was expressed as percentage of injected activity. The uptake of Fe^{59} in control groups reached its maximum value of around 80 to 90% of the injected amount on the fifth day after injection. In the irradiated group the uptake was depressed markedly initially and then rose to a constant maximum value at a level lower than that of the control animals. The uptake of Fe^{59} expressed as percentage of control was depressed exponentially as the doses increased. The plasma disappearance time also delayed exponentially as the doses increased. All the values of the RBE obtained were in good agreement with those of other authors. It is concluded that the measurement of Fe^{59} uptake provides a sensitive and reasonable quantitative indication of bone marrow depression following irradiation and a suitable indicator for the RBE of bone marrow function. (A.G.W.)

30079 EXPERIMENTAL STUDIES ON THE ELIMINATION OF RADIOACTIVE STRONTIUM. Eiichi Ogawa, Shiro Suzuki, and Hiroshi Tsuzuki (Gunma Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 63-5(1963). (In Japanese)

Mice were subcutaneously injected with Sr^{90} or Sr^{85}, and effects of various drugs on their 3-day excretion and retention on the 4th day were investigated. Among chelating agents, NaCa citrate, NaMg citrate, NaSr citrate, Achromycin (or tetracycline), and aspartic MgK (alone or in combination with NH_4Cl) displayed Sr-eliminating effects. ATP increased only the excretion without diminishing the retention in bone. EDTA, DTPA, BADE, tricarballylate, Na citrate and NaPb citrate were not effective. Among salts, Mg salt, sulfate, and thiosulfate were effective in eliminating Sr. The last exerted a greater effect when given concurrently with Mg, Ca, or Sr salt. Ca and Sr salt exerted no effect, and ammonium chloride promoted only urinary secretion, not extending to fecal or total excretion. Such salts as induce alkalosis conversely exerted inhibitory effects. Among hormones, glucocorticoids had Sr-eliminating effects. TSH was effective, and antithyroidal drugs conversely seemed to have excretion-diminishing effects. Among vitamins, cocarboxylase increased Sr excretion, but did not decrease the retention in bone. Also metabolic inhibitors were ineffective, and NaF conversely increased bone deposition of Sr. Among diuretics, SH-drugs, and weak chelating agents, there were no effective drugs. (JAIF)

30080 STUDIES ON THE RADIOACTIVE DUST. I. RELATIVE DUST COLLECTING EFFICIENCIES OF DIFFERENT FILTER PAPERS. Yasushi Nishiwaki (Tokyo Inst. of Tech.), Yoshihide Honda, Takeo Harada, Hidebumi Shimizu, Hiroshige Morishima, Yuichiro Kimura, Taeko Koca, and Takeo Niwa. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 66-8(1963). (In Japanese)

In order to estimate the radioactivity contained in airborne dust accurately, it is necessary to know the dust collecting efficiencies of the filters under different conditions. Although the dust collecting efficiencies may be influenced by the size of the dust, humidity, flow-rate, and various other factors, the relative dust-collecting efficiencies of some filter papers were examined with naturally occurring radioactive dusts. The dust collectors used in this experiment were DS-200 (dust monitor) and DS-8B (dust sampler) of Kobe Kogyo K. K., both fixed filter paper type. The filter papers examined were Staplex No. 41 (U.S.A.), Toyo Filterpaper Co. No. 5A (Japan), and some other filter papers. The radioactivities collected on the filter papers were estimated from the decay rate to daughter products of radon and thoron origin. As an index of the dust collecting efficiency the radioactivity collected on the filter paper at equilibrium state was used. The possible effects of flow rate, size of the dust, self absorption of soft radiation, and decay rate of the radioactivity were also discussed. The results indicated that there was no significant difference in the relative dust collecting efficiencies of the Staplex No. 41 and the Toyo Filterpaper Co. No. 5A. (JAIF)

30081 INTERNATIONAL COMPARISON OF RADIOACTIVE STANDARDS. Masashi Naito (Tokyo Inst. of Tech.), Yajiro Inoue, Osamu Yura, Kogoro Maeda, Yasushi Kawada, and Tsutomu Noguchi. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 69-71(1963). (In Japanese)

A series of international comparisons of radioactivity standards have been carried out since February 1961 by the simultaneous measurements of the distributed standard samples by the participating laboratories under the auspices of "Bureau International des Poids et Mesures." The nu-

clear species used for the comparison-measurements are I^{131}, Au^{198}, Co^{60}, and S^{35}. The measuring methods and the results on the four nuclides obtained in the Electrotechnical Laboratory are described and compared with those from the other participating laboratories. The values obtained from the measurements are in satisfactory agreement with those from the other laboratories participating in the comparison program. (A.G.W.)

30082 DIRECT DETECTION OF RADIOACTIVITY IN WATER BY MEANS OF GAMMA RAY. Masao Kato, Otomaru Sato, and Mitsuo Matsusaka (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 72-4(1963). (In Japanese)

Theoretical treatment of underwater detection of radioactivity by gamma rays homogeneously dispersed in water is described. The geometrical efficiency of the tank used in this study is discussed. It was found that the efficiency of the tank (1.5 × 1.5 × 1.5m) was more than 95% for sodium-24, and a method was exploited by which the efficiency in infinite volume was extrapolated from the experimental result in finite volumes. As the counting rates obtained by experiment were three or four times more than the theoretical ones with high energy gamma rays owing to their scattering effect, the authors measured gamma-ray spectra in water containing homogeneously dissolved gamma emitters and investigated counting rates corresponding to some selected energy ranges using a new underwater measuring apparatus equipped with a pulse height analyzer. The measurement of radioactive solution in a pipe and the dip counting of one- or two-liter samples are described. (A.G.W.)

30083 MEASUREMENT OF LOW LEVEL TRITIUM. T. Takahashi, S. Ohno, and T. Hamada (Inst. of Physical and Chemical Research). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 75-7(1963). (In Japanese)

Tritium in samples of rain and city water collected during the past 3 years was measured. The tritium in a 60-g sample of water was concentrated 10 to 15 fold by electrolysis and the final concentrate was counted as hydrogen in a counter. The 21-copper counter was filled with hydrogen and good counting characteristics (about 1.3%/100V slope over 200V) were obtained at a hydrogen pressure of one atm using a multivibrator quench circuit. One cpm of this counter corresponds to 95 ± 1 tritium atoms per 10^{18} atoms of hydrogen. Rain samples collected in Tokyo and Kochi until November 1961 were found to range from 29 to 96 $(T/H) \times 10^{-18}$. Tritium values, which had showed marked effects of the thermonuclear tests in the autumn of 1961, rose to 1330 $(T/H) \times 10^{-18}$ in June 1962. The tritium concentrations in city water samples collected in Tokyo in April and August 1962 were found to be 100 and 120 $(T/H) \times 10^{-18}$, respectively. (JAIF)

30084 FUNDAMENTAL EXPERIMENTS ON MEASURING RADIOISOTOPES IN PATIENT'S WHOLE BODY FROM OUTSIDE. H. Kakehi, N. Arimizu, K. Saegusa, and T. Mori (Chiba Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 78-80(1963). (In Japanese)

In order to measure from 1 to 1000 microcuries of radioisotopes distributed in the human body, two methods were devised. One is a hot-patient counter, which measures activities from a distance of 2.5 m. It is equipped with a 2" × 2" φ NaI crystal and a medical spectrometer. The other is a linear scanner, which measures each part of the body from head to feet at a short distance. The total sum of the counts of each part represents activities in the whole body. It is composed of two medical spectrometers and two detectors. Each detector has a 2" × 2" φ and a 1" × 1" × 4" NaI crystal above and below the patient's bed respectively. The measurements were performed on many kinds of body phantoms and many patients. Experience indicates that measurements of patients should be made in the interval between the administration of radioisotopes and the first excretion so as to get the correct values. The results are not so precise as those obtained by a human counter, but they are precise enough for use in medical diagnosis or treatment. (A.G.W.)

30085 THE ACCURATE MEASUREMENT OF SHORT-LIVED ISOMERS OF THE ORDER OF SECOND. Tokishi Kaminishi and Chiyo Kojima (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 81-3(1963). (In Japanese)

In order to measure half lives of a few seconds with higher accuracy than that previously reported, improvements were made on some parts of the apparatus and almost all were automatized. A whole apparatus can be classified in three parts as follows: (1) the sample transferring system; (2) the counting system; (3) the counting control system. A sample is transferred to the irradiating position by a pneumatic conveyer. After irradiation the sample is automatically brought to the well-type scintillation detector by the same conveyer. A signal, produced by the passage of the sample across the light beam in the optical sample detector, is used for the timing signal that controls the counting system. The timing signal is supplied by a crystal oscillator and a time duration can be easily selected by panel switches in the range from 0.01 to 100 sec. As an improved method of measuring weak and rapidly decaying radioactivity with adequate accuracy, the overlap counting technique was introduced in the third part. The counting control system consists of a number of gate circuits, each of which is a self-controlled structure having simple circuitry with an inhibiting input and also an inhibitor to the following gate. By the use of both gating circuits and multiscalers, the overlap counting is possible. That is to say one of the scalers can be still in "count" during the preset time when the next scaler has begun to count a certain later time. A printing scaler and a multichannel pulse height analyzer are also used for measuring simultaneously long lived components and transition energies respectively. Half-lives of some short-lived isomers in question were measured with an accuracy of approximately 1–2%. Values obtained over several runs are as follows: Br^{79m} (4.80 ± 0.05) sec; Er^{167m} (2.10 ± 0.05) sec; W^{183m} (5.40 ± 0.1) sec; Ir^{191m} (4.90 ± 0.05) sec. The values of other isomers such as Se^{77m}, Ag^{47m} + Ag^{49m}, Hf^{179m} and Au^{197m} are in good agreement with those of references. (JAIF)

30086 14C AND 3H MEASUREMENT BY THE USE OF A LIQUID SCINTILLATION SPECTROMETER IV. DETERMINATION OF COUNTING EFFICIENCY BY THE DISCRIMINATOR RATIO METHOD. Yoshiko Kasida, Tetsuo Iwakura, and Naoko Morisaki (National Inst. of Radiological Sciences). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 84-6(1963). (In Japanese)

A method for the determination of the counting efficiency in liquid scintillation counting was studied. When the sample having a special chemical form is incorporated in a scintillator, the scintillation process is quenched to some degree to result in an attenuation of light output which causes a downward shift of the pulse height spectrum. Then, if three discriminators are set to observe different parts of the spectrum, the ratio of pulses in one window

to those in others will vary with the quenching degree of the scintillator and may be used as an index of the counting efficiency. The spectrometer used in this experiment was TRI-CARB Model 314 A (Packard Instrument Co.) equipped with three discriminators and two scalers. A number of samples containing the same amount of C^{14} activity were quenched to various degrees by using methanol and acetone as chemical quenchers. The lower discriminator was set to 10 v, middle and upper discriminators (B,C) were adjusted, by trial and error, so that the count ratio of one scaler to the other might show a linear relationship to the counting efficiency in window A-C. The same procedure was applied to tritium. It appeared that the linearity of plots was impaired slightly when either the setting of the middle discriminator was not optimal or photomultiplier voltage was higher than the balance point window A-C. An important conclusion obtained is that these two types of quencher, i.e. mild and strong quencher, gave the same effect on the relation of shift of pulse spectrum to the counting efficiency. This fact implies that the quencher used to obtain the calibration curve may be not necessarily restricted to the same compound as counting material. In the case of C^{14}, the discriminator ratio changed at nearly the same rate as the efficiency. In the case of tritium, even a small change in the discriminator ratio brought about a large change in the counting efficiency. (JAIF)

30087 LIQUID SCINTILLATION COUNTING OF TRITIUM IN AQUEOUS SOLUTION. Toshie Hattori, Hajime Takahashi, and Bunji Maruo (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 87-9(1963). (In Japanese)

In order to determine whether or not commercial reagents of naphthalene and dioxane are suitable for the preparation of scintillation solvents, an experiment was conducted in which commercial and laboratory purified dioxane and naphthalene were combined to produce three kinds of dioxane scintillator systems. The counting efficiencies, using H^3-water, were compared. The results indicated that there were significant differences in counting efficiencies among the systems. The solvent described by Werbin et al. gave the highest counting efficiency among those tested. Appreciable difference in counting efficiency between laboratory and commercial preparations was also noted. The difference, however, was not so great as to suggest that commercial reagents could be used without further purification in the ordinary assay of tritium. It was found that the addition of a small amount of hyamine hydroxide to aqueous solutions of various organic compounds considerably improved the solubility of these compounds in the dioxane-naphthalene-water system. Relatively high counting efficiency could be obtained for H^3-determination with the hyamine-water-dioxane system. (JAIF)

30088 CAPABILITIES OF THE PERSONNEL MONITORING BADGE IN JAERI. I. Miyanaga, H. Yamamoto, K. Bingo, T. Nishi, Y. Izumi, and M. Saito (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 90-2(1963). (In Japanese)

For the purpose of personnel monitoring for external radiations in JAERI, where mixed radiation fields of γ rays, β rays, and neutrons are usually encountered, special badge meters have been developed since 1958. A table shows the type of these badges and their constructions. In this report, the capabilities of the newest badge are shown by measuring the true dose absorbed by the body from experimental data. The photon energy response was nearly constant (within a variation of $\pm 20\%$) between 200 kev and 10 Mev. The effects of directional dependence of the γ radiation were negligible above 200 kev, but became quite large as the energies decreased. The latent image stability of γ-ray film was less than 10% during 4 months in the air-conditioned room, but that of Kodak P.N.M. film for fast neutrons deteriorated as much as 90% in one month. The latter was improved to 20% in one month by wrapping the film with "Krewrap" and using an airtight badge. The method of differential measurements of mixed radiation fields is presented. Especially for γ rays, the relation between badge response and tissue dose is discussed, considering the effects of directional dependence of the badge and back-scattered radiations from the body. (JAIF)

30089 LOW LEVEL AND SOFT BETA RAY AQUEOUS WASTE MONITORING ARRANGEMENT WITH DIP TYPE THIN MICA WINDOW BETA COUNTERS. Hiroo Sato (Japan Radiation and Medical Electronics, Inc.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 93-5(1963). (In Japanese)

An improved dip-type thin-mica-window G-M tube with window thickness of the order of $1.5 - 2.0$ mg/cm^2 is described. The thin mica window is verified to bear up to 20 meters water pressure on a window area of 23.5 cm^2. It is so constructed that the arrangements possess both an aqueous waste monitoring system and anticoincidence circuits of ordinary low level counters. The beta counter is equipped with two dip-type thin-mica-window G-M tubes, and these mica windows are placed face to face at 1 cm distance. When aqueous waste passes through the space between the two windows, radiation from the solution is measured. The above beta counter is surrounded by an array of G-M tubes in anti-coincidence. Instead of many G-M tubes, however, the present method employs only one specially designed guard counter. The performance of the scaling instrument is not appreciably different from that of the ordinary low level counters. The performance is summarized by the following data: residual background counting rate is 8–10 cpm, and measurable radioisotope concentrations in specific volume of solution are 5×10^{-4} μC/cm^3 in C^{14}, 2×10^{-4} μC/cm^3 in S^{35}, and 10^{-6} μC/cm^3 in $Sr^{90} + Y^{90}$. (A.G.W.)

30090 MOISTURE AND DENSITY DETERMINATION IN SOIL. I. Abid, F. H. Hashmi, and S. A. Husain (Atomic Energy Center, Lahore, Pakistan). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 96-7(1963). (In English)

The neutron moderation technique was applied for the determination of moisture in the soil. The probes consisted of enriched boron trifluoride counters and a 100-mC Ra–Be neutron source. For moisture measurements the probes were placed on the surface of the soil and inserted into the soil. The region of nonlinear response for lower moisture contents reported in earlier work is significantly reduced. The density of the soil was determined by measuring the attenuation of backscattered γ rays by the soil, using a Cs^{137} source and a cylindrical G-M counter. (A.G.W.)

30091 THERMAL NEUTRON ABSORPTION BY ELEMENTS IN SOIL AND CORRECTION OF MOISTURE CONTENT MEASURED BY NEUTRON MOISTURE METER. H. Ono (Central Research Inst. of Electric Power Industry). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 98-100(1963). (In Japanese)

It is a characteristic feature of a neutron moisture meter that measured values are more or less influenced by the composition of the material. The counting rate of thermal neutrons decreases in this meter when a measured mate-

rial contains elements of large absorption cross section for thermal neutrons. It is necessary in such cases to correct the moisture content measured by the moisture meter. Chlorine's absorption cross section is especially large, compared with other elements found in soil, and even a small amount has much influence on the indication of the meter. There are some cases when the existence of nitrogen and iodine cannot be considered negligible. It is very troublesome to prepare various samples which contain proper amounts of these elements so that one may obtain correction factors from experiment. Thermal neutron flux incident into a detector can be calculated from the two group diffusion equations of neutrons. Accordingly, the decrease of thermal neutron counting rate due to the existence of special elements can be calculated, too. A correcting method by calculation is offered in this paper. A good agreement is found between experiments and calculations for various concentrations of chlorine in salt water. This correcting method was successfully applied to a field test exercised in the reclaimed formation near the coast. (JAIF)

30092 AUTOMATIC ISODOSE PLOTTER. Kiyomi Nishibori, Shigeyasu Kurihara, and Takeshi Kato (Tamagawa Works. Tokyo Shibaura Electric Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 101-3(1963). (In Japanese)

The measurement of dose distributions of radiation is one of the most important techniques in radiation therapy, but the manual execution of this procedure is tedious, rather inaccurate, and time consuming. In this paper an instrument for automatic recording of isodose curves is described. This instrument is composed of three devices: detector driver, controller, and recorder. A detector is driven by two reversible motors; one is a scan drive and the other is an error compensation drive. Sequential alteration of the roles of the two motors provides complete mapping of the continuous isodose curves. Many isodose curves for several kinds of radiations were recorded using this instrument and recording accuracy is found to be 2%. Plotting speed is about 40 minutes for a family of ten contours in a 40 × 40 cm plotting area. This instrument can be effectively applied for spatial intensity distributions of electric field, light, photographic density, etc. (JAIF)

30093 SEMICONDUCTOR NUCLEAR RADIATION DETECTORS. Jitsuo Terada, Juzo Yoshida, Yasuo Ebara, and Tetsuji Kobayashi (Tokyo Shibaura Electric Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 104-6(1963). (In Japanese)

Silicon p-n junction detectors were fabricated by diffusing phosphorus to 2μ depth into high resistivity p-type silicon. Various base material resistivities were employed, ranging from 1000 Ω-cm to 9000 Ω-cm. The devices produced have an encapsulated construction which preserves a good protection of the junction edge. Devices of 2-mm, 5-mm, and 12.5-mm sensitive diameters were tested. Linear response of the detector to 20-Mev alpha particles and signal rise times of several nanoseconds were observed. A neutron-sensitive detector was constructed by depositing a thin layer of Li^6F between two junction detectors. Neutrons were detected by observing the α + T pair resulting from the $Li^6(n,\alpha)T$ reaction. Gamma-ray dose-rate measurements were carried out using the junction detectors as solar cells. The short-circuit current of the detector was proportional to the intensity of the incident radiation. When a scintillation crystal is optically coupled to the detector, the photocurrent increases. Open-circuit voltage of the junction detector is sensitive also to gamma-ray dose-rate. The open-circuit voltage increases linearly at low dose rate. Lithium ion-drifted p-i-n silicon detectors were prepared by diffusion of lithium into p-type silicon followed by electric-field-drift in an oil bath at temperatures ranging from 100° to 200°C. Resistivities of the base materials of some 100 ohm cms and 1000 ohm cms were employed. Extension of the sensitive region was directly observed with a microscope by etching the side of the drifted element. More than 1000μ of drifted depth was achieved, while the window thickness of the detector was estimated less than 20μ. The lithium-drifted detectors have an encapsulated construction like the junction ones and a sensitive diameter of 5 mm. (A.G.W.)

30094 RADIOASSAY BY GAS CHROMATOGRAPHY-FLOW COUNTER UNIT AT ELEVATED TEMPERATURE. Yutaka Tanaka (Inst. of Physical and Chemical Research) and Alfred P. Wolf. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 107-9(1963). (In Japanese)

A new technique for the simultaneous separation by gas chromatography and immediate assay of radioactivity of the separated vaporized components of radioactive labeled liquid state organic compounds is proposed. Helium, which carries the material to be separated through the column of gas chromatograph and thermal conductivity cell, is converted into a counting gas by the continuous injection of methane. The mixed hot stream of helium and methane then passes through an internal gas proportional flow counter of special design, which detects the radioactivity of the vaporized material carried. This new method should find a wide field of application for investigation of liquid state radioactive labeled organic compounds. The most important factors that affect the accuracy and efficiency of this counting method at elevated temperature are discussed. (A.G.W.)

30095 GAMMA-RAY DETECTOR USING INSULATING MATERIALS. Junichiro Furuta, Eiichi Hiraoka, Shinichi Okamoto, Tamotsu Kanazawa, and Toshio Azuma (Radiation Center, Osaka Prefecture). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 110-11(1963). (In Japanese)

Secondary electrons are produced by the interaction of gamma photons with atoms. Within a region of few Mev, the gamma photons interact with low atomic number materials mainly by the Compton effect. So they generate a flux of Compton electrons that moves along the incident beam. When these electrons move between electrodes, the directional current is proportional to the incident gamma flux. The experiments described were done by the use of 1000 C Co^{60} and ORC-Linac. The detector consists of the dielectric scatterer and the lead absorber. The output of the collector is read by means of a vibrating reed electrometer. The collected current densities of the lead absorber are about 3×10^{-14} amp/r/min/cm^2 for both the gamma ray of Co^{60} and the x ray of Linac. It almost coincides with the value calculated using the Compton scattering theory. (JAIF)

30096 HIGH DOSE FERROUS DOSIMETRY FOR Co-60 γ-RAYS. Takeshi Sawai, Yoshiharu Shinozaki, and Gisuke Meshitsuka (Tokyo Metropolitan Isotope Center). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 112-14(1963). (In Japanese)

A simple method of high level dosimetry for Co^{60} γ rays was studied with the use of ferrous salts (ferrous ammonium sulfate or ferrous sulfate) in sulfuric acid solution, without degassing or nitrogen substitution. The relationship

between irradiation dose and the concentration of ferric ion produced was examined in the presence of various concentrations of solutes. The linear relationship obtained in the oxygen-exhausted region can be extended to higher dose by using higher concentrations of ferrous salt and sulfuric acid. In a system of 0.5M ferrous ammonium sulfate in 5N sulfuric acid, the linearity holds up to 1.2×10^7 r. The oxidation yield of ferrous ion, however, decreases with increasing solute concentration. It has been shown that the decrease of $G(Fe^{3+})$ is due to both ammonium and molecular sulfuric acid. For high level dosimetry, it is desirable to use a lower concentration of sulfuric acid (~0.8N) and a higher concentration of ferrous sulfate (~0.5M) instead of ferrous ammonium sulfate. In the system of ferrous sulfate in 0.8N sulfuric acid, $G(Fe^{3+})$ is almost independent of ferrous sulfate concentration up to 0.5M. In the case of 0.5M ferrous sulfate in 0.8N sulfuric acid solution, the linearity between irradiation dose and the concentration of ferric ion produced holds up to 6×10^6 r, and $G(Fe^{3+})$ is 8.01 ± 0.13. This method can be applied for the determination of dose rate of megacurie Co^{60} source as well. (JAIF)

30097 THE CONTINUOUS DOSIMETRY BY USE OF THE CHEMICAL DOSIMETER. Ken'ich Sugimoto (Radiation Center, Osaka Prefecture). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 115-17(1963). (In Japanese)

Continuous electric measurements were applied to rapid and continuous dosimetry using chemical systems. In the Fricke dosimeter, ferrous iron is oxidized to ferric iron in an air-saturated solution of ferrous sulfate in 0.8N sulfuric acid. The chemical change is easy to follow through the measurement of the oxidation-reduction potential of the ferrous-ferric iron couple. Here a zero current potentiometry was applied to the simple continuous dosimetry. The error was within 2 per cent under suitable conditions. Good reproducibility over the wide range for the potential measurements was an important feature. The radiation-induced chemical reaction of aqueous chloral hydrate solutions is the conversion of chloral hydrate to hydrochloric acid. The chemical change is easy to follow through the measurement of electric conductivity since the main reaction consists in the conversion of the very slightly ionized organic molecule to a highly ionized inorganic halide. Consequently, the continuous measurement of electric conductivity was used for chemical dosimetry. The reproducible data obtained suggest that this system can be used as a dosimeter for lower doses of gamma irradiation. Aqueous hydrochloric acid solution of stannous ion, exposed to the gamma irradiation from cobalt-60, yields stannic ion as the product. Formed stannic ion was determined continuously by polarography during the irradiations. The reduction of stannic to stannous ion produced waves suitable for the analytical purpose when the supporting electrolyte was 6N hydrochloric acid. The reproducible data obtained on the diffusion current measurement of stannic ion suggest that this system can be used as a dosimeter for higher doses of irradiation. (A.G.W.)

30098 A SURVEY ON DEPTH DOSE DISTRIBUTIONS OF TELEISOTOPE RADIATION THERAPY. Masasi Fukuda (Kyoto Univ.), Susumu Morikawa, Ikuo Kimura, Yoichiro Umegaki, Moriji Fujino, Goro Kusumoto, Yoshio Onai, Syunzo Okajima, and Giichi Yoshii. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 118-20(1963). (In Japanese)

The study group on "Measurements of Depth Dose Distributions for High Energy Radiation Beam" has planned to standardize depth dose data of the telecobalt and telecesium therapy in Japan. Depth dose data on five telecobalt fixed field units, one telecesium fixed field unit, three telecobalt rotational units, and one telecesium rotational unit were offered from the fourteen institutions with hospital physicists. In telecobalt therapy, 60 isodose charts for normal incident fixed field and a few charts of oblique, wedge, and split fields were discussed. It was found that the central axis percentage depth dose for the same field size measured in different institutions agreed within about 3% of the local dose in the case of the medium and long source-surface distances. In the short-surface distance, however, considerable discrepancies between the local doses were observed. There were only four isodose charts in the telecesium therapy. There were 34 isodose charts for the constant source-tumor distance, where the dose at the depth of 15 cm was expressed as 100%, and it is found that they were very convenient in the fixed-field therapy using rotational units. In the rotational therapy, it was difficult to standardize isodose distributions from the experimental data in various units, since the differences of penumbra had a considerable effect upon the depth dose distributions. (JAIF)

30099 LIQUID SCINTILLATION COUNTER. H. Ueyanagi, H. Inoue, K. Nakamura, and S. Kawamura (Shimadzu Seisakusho Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 121-3(1963). (In Japanese)

A home-made liquid scintillation counter is used to measure low-energy β rays emitted from C^{14}, H^3, and other isotopes with a small volume liquid scintillator. The scintillator used is PPO 4 g/l and POPOP 0.1 g/l in 20 cc of toluene. Two photomultipliers are used to compose a coincidence system. The detector unit is set in a freezer, and detector temperature is controlled around 0–10°C to reduce thermal noises. The counting efficiency for C^{14} is 85% or better and the background counting rate is about 30 cpm, and for H^3, 15% or better and about 50 cpm. With appropriate setting of the conditions of three amplifiers and a two-channel pulse height analyzer, the double tracers such as H^3 and C^{14} can be measured at the same time. The efficiency must be calibrated for each sample measured. Several methods of calibration are discussed. (A.G.W.)

30100 A PROTO-TYPE LIQUID SCINTILLATION COUNTER USING CURRENT MODE IMPEDANCE MATCHING FOR LOW ENERGY BETA COUNTING. H. Miwa, T. Furuya, M. Maeda, and U. Asayama (Atomic Energy Div., Kobe Kogyo Corp.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 124-6(1963). (In Japanese)

A prototype liquid scintillation counter was made for measuring H^3 and C^{14} activities using current mode impedance matching circuitry. This instrument is capable of counting by four sizes of sample vial, 20, 50, 100, and 150 ml. The detector assembly consists of two high signal-to-noise ratio photomultiplier tubes which are mounted at right angles and shielded from external radiation by 2" thick lead shields. Current pulses from each detector are fed into the fast coincidence circuit to reduce the thermal noise of the photomultiplier tubes, and for eliminating the high energy pulses, its output pulses are anticoincidenced with the pulses that exceed the upper level discriminator. The photomultiplier tubes, reflector material of a counting cell, and counting vial material are selected experimentally, because these problems are vital points in improving this instrument. It is concluded that this instrument can operate satisfactorily at room temperature, and the lower K^{40} glass vial gave 1.5 times the background count of the quartz one. Typical results of measuring H^3 and C^{14} sam-

pies using toluene-H^3 and benzoic-C^{14} acid respectively, at room temperature (18.0 ± 0.5°C) are given in a table. The composition of scintillator was 4 g/l of PPO, 50 mg/l of POPOP in air-saturated toluene. Operating voltage is fixed at the balance point that gives maximum count at the various window widths. (JAIF)

30101 A LIQUID SCINTILLATION SPECTROMETER. Noboru Tokunaga (Japan Radiation and Medical Electronics Inc.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 127-9 (1963). (In Japanese)

The device described has a single-type counting head unit with a 2" diameter E.M.I. 9536S photomultiplier tube, selected for the lowest noise level. The single-type head unit has a high counting efficiency but a relatively high counting rate of background in comparison with the coincidence-type with two photomultiplier tubes. For decreasing the background, the detecting unit is put in a special housing with 5 cm of lead shielding. The principal feature of this unit is a rotary sample-changing device with three samples, which allows samples to be changed without exposing the photomultiplier tube to light. The thermionic noise of a photomultiplier tube is decreased to the value of $\frac{1}{5}$ when the temperature is lowered from 5°C to −10°C in a freezer. The background counting rate of a sample cell without liquid scintillator is about 250 counts per minute. With the coating sample cell covered on the inner surface with Al-foil and taped by black tape around the outside, the background counting can be lowered within a fluctuation of the noise counting rate from a photomultiplier tube. Using this device, H^3 counting efficiency was obtained up to about 36% for 10 cps backgrounds with counting rate at −10°C. (A.G.W.)

30102 ON STABILITY OF A MEDICAL SCINTILLATION SPECTROMETER. H. Ueyanagi, K. Hosoi, T. Miyake, and A. Kawakatsu (Shimadzu Seisakusho Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 130-2(1963). (In Japanese)

Recently, a compact and reliable single-channel scintillation spectrometer has become widely used in the field of nuclear medicine to eliminate undesirable background or select the radiations of a particular isotope. Results of experiments on the stability of the modified spectrometer, originally developed by J. E. Francis and P. R. Bell, against variation of ambient temperature and line voltage are described here. The preamplifier shows a negative variation coefficient with increasing ambient temperature and line voltage. Gain variation of the main amplifier with increasing line voltage shows positive, and gain variation with increasing ambient temperature shows negative. The pulse height analyzer is very stable under temperature and line voltage variation. The ratemeter circuit shows positive variation of the indication with increasing line voltage and negative variation with increasing ambient temperature. Variation of the circuit of the high voltage power supply with increasing line voltage shows a negative coefficient. No general tendency of variation with ambient temperature could be recognized. From the results of the experiments described, another modified model of the original spectrometer was constructed for medical uses. (A.G.W.)

30103 THE REPRESENTATION OF THE RESOLVING POWER OF SCINTILLATION COUNTER USING RESPONSE FUNCTION. Toru Yoshioka and Tamon Inouye (Tokyo Shibaura Electric Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 133-5(1963). (In Japanese)

The resolving power of the scintillation counter is usually represented by the half-width of the output pulse-height distribution corresponding to the input of the monoenergetic γ ray. In this paper, a new method for representation of the resolving power is introduced, which uses response function. Provided that the linear relation between the input and the output and the constancy of the energy change is satisfied, the Fourier-transformed function of the output pulse-height distribution corresponding to the monoenergetic γ ray will be appropriate to represent all the characters of the system. This function is referred to here as response function in the same way as in optics. If the input is sinusoidal, the output intensity I is related to the absolute value of the response function in the form of Imax − Imin/Imax + Imin, and this value is obtained from the experiment. It can be easily shown that the first zero point of the response function corresponds to the energy-frequency decided by the resolving power in the ordinary meaning. The experiment is carried out by choosing many combinations of the γ-ray-emitting radioisotopes with small energy differences and comparing the resolution for different energy intervals with the response functions calculated from the triangular and the Gaussian output distributions corresponding to the monoenergetic γ-ray input. In the former case, the calculated value shows a good agreement with the experiment. In the triangular case, the response function vanishes periodically and has finite value beyond the first zero point. Therefore, the resolution of the γ rays of smaller energy interval than the usually defined resolving power can be observed, and this strange phenomenon is easily understood by the concept of the response function. (JAIF)

30104 TEMPORARY MEMORY DEVICE OF THE HIGH COUNTING RATE MULTICHANNEL PULSE HEIGHT ANALYZER WITH DELAY LINE MEMORY. Yoshio Moriwaki (Tokyo Univ.), Shingo Mihara, Toshiaki Terakawa, Hirohide Miwa, Hajime Hayashi, and Toshiyuki Nishimoto. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 136-8(1963). (In Japanese)

By incorporating several temporary store circuits, the dead time of a multichannel pulse height analyzer with a delay line memory was reduced to that of the A-D converter. A block diagram shows three sets of temporary store circuits, and their operation is described. The system can be easily extended to any number of sets. (A.G.W.)

30105 A DELAY LINE MEMORY SYSTEM FOR THE HIGH COUNTING RATE PULSE HEIGHT ANALYZER. Yoshio Moriwaki (Tokyo Univ.), Toshiaki Terakawa, Shingo Mihara, Hirohide Miwa, Hajime Hayashi, and Toshiyuki Nishimoto. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 139-41(1963). (In Japanese)

A delay line memory system to be used with a pulse height analyzer capable of analyzing several pulses during one memory cycle is described. The synchronizing pulse generator generates a synchronizing pulse, which is circulated along the delay line and gives a reference of phase, so that the pulses in each channel of the memory will come out in phase with the addition signals from the binary converter. In the write-in circuit, the output pulse of the adder modulates a carrier of 15 Mc, and this modulated pulse is applied to the input transducer of the delay line. The output transducer of the delay line gives a delayed modulated pulse about 70 db below the level of the input. The read-out circuit consists of an amplifier, a detector, and a pulse shaping circuit and compensates for the loss in the delay line and the transducers and reshapes the

pulse waveform. In the digit and channel pulse generating circuit, the synchronizing pulse starts a pulsed oscillator that generates a pulse train of 1011 pulses. The decimal counter gives a channel pulse for every ten digit pulses. The binary converter and the adder are the most important components of the system. When two or more pulses of the same height are analyzed during one memory cycle, two or more must be added to the content of the corresponding channel in the memory. The binary converter converts the binary expression of the number to be added into a corresponding series of pulses. The output of the binary converter and the content of the memory are added together in this circuit, which gives the sum as its output. (JAIF)

30106 SOME OBSERVATIONS ON SCINTILLATION CAMERA PICTURES. Mizuki Mori and Nobuo Kasahara (Japan Radiation and Medical Electronics, Inc.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 142-4(1963). (In Japanese)

The specific factors which affect the distortion and sharpness of scintillation camera pictures were studied. Two crystal assemblies having the same thickness, one with a reflector material and the other with an absorbing material, are tested and comparison is made on the distortion of the pictures. The effect of the crystal thickness is also discussed, and data are given for the crystals of $\frac{1}{2}$ in. and $\frac{1}{4}$ in. thickness. By using the half-tone display direct view storage tube 7448, the background flashes are eliminated and precise definition of the images is obtained. (JAIF)

30107 A STUDY ON AREA SCANNING WITH I-125. Hirotake Kakehi, Noboru Arimizu, and Takekuni Kasuga (Chiba Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 145-7(1963). (In Japanese)

Attempts to scan the thyroid gland and liver with I^{125} are described. The scanner used is equipped with a honeycomb collimator of 19 holes and focussed at 5 cm, a 2 in. × 2 in. ϕ NaI crystal, and a medical spectrometer. Scannings were experimentally performed on many water phantoms, each containing 20 to 500 μC I^{125} and I^{131}, shaped like various-sized thyroid glands and livers with various-sized tumors in them. Differential counting measurements were taken on all experiments. When I^{125} is used in the area scanning, the contours of the thyroid gland are clearly delineated, and the background is very low. Therefore, it is very easy in I^{125} thyroid scanning to get the accurate size of the thyroid gland and to find the cold nodules of the gland, compared with I^{131}. These fine scannings are obtained by the oral administration of about 50 μC of I^{125} to the patients, except in the case of hypothyroidism. In case of hyperthyroidism, the thyroid scanning is possible by administering smaller doses of I^{125}. On the other hand, it is difficult to measure thyroid I^{125} uptake accurately because of its low energy. If thyroid uptake measurement and thyroid scanning are done at the same time, it is proper to give 10 μC of I^{131} with I^{125} to the patient. By a differential counting measurement, the precise thyroid uptake is determined. In this case, the influence of the scattered radiations of I^{131} on the scintigram with I^{125} is slight, and fine thyroid scanning is obtained. In the case of liver scanning, tumors in the shallow region of the liver are exactly found by the use of I^{125}. However, it is almost impossible to find deep-seated tumors of the liver by I^{125} scanning. The deep-seated tumors of the liver are easily found by the use of I^{131}. In the liver scanning, it is suitable to use I^{125} at first and then scan again with I^{131} or Au^{198}. By this method more information on changes in the liver can be obtained than by scanning with I^{131} only. (JAIF)

30108 ON ONE METHOD OF QUANTITATIVELY DISPLAYING DISTRIBUTIONS OF RADIOISOTOPES IN A HUMAN BODY—MULTICOLOR SCINTIGRAM. M. Ozeki, Y. Furukawa, H. Ueyanagi, M. Toda, and S. Nakanishi (Shimadzu Seisakusho Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 148-50(1963). (In Japanese)

The device called a multicolor scintiscanner has 4 describing heads mechanically linked so as to move with the scintillation detector and describe 4 controlled scintigrams on 4 separated papers. Control of describing the scintigram is executed as follows: number 1 head only describes the scintigram of the portion where the amount of the radioisotope is 20 ~ 40% of the maximum amount of deposition in the organ being examined, numbers 2, 3, and 4 correspond to 40 ~ 60%, 60 ~ 80%, and larger than 80%. Each head has a mechanically dotting device and each scintigram is described on typewriting papers through a duplicating color paper, with a different color corresponding to each head. With this system, amounts whose ratio is about 1:1.2 or less can be distinguished. A complete colored scintigram can be made up in the duplicating process. One of the instrumental difficulties is rather slow time response of the counting-ratemeter system that selects the describing head to be actuated. The counting ratemeter has a parallel network of a resistance and a capacitance as the time integrator. Its time constant should be small for quick response, but large for accuracy of selection of describing heads. Another factor relating to the time response of the whole system is the scanning speed of the scintillation head. The slower scanning speed would give a more faithful scintigram, but from another point of view, the scanning speed should be quick as possible. The optimum scanning speed, in the case of the multicolor scintiscanning, was investigated. (JAIF)

30109 COLORED RI SCANNING APPARATUS. Kiyomi Nishibori, Shigeyasu Kurihara, and Takeshi Kato (Tokyo Shibaura Electric Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 151-3(1963). (In Japanese)

A new type color-ribbon scanner for mapping in vivo distribution of radioactivity was developed. Colored ribbons (red, black, blue, purple and green) selected by a servomotor controlled by the output of a count-rate meter, are tapped by a magnetic actuator in response to pulses from a scaler. In the colored scintigram, each color corresponds to the percentage count-rate and each dot to a gamma-ray photon. Five colors were used so that each 20 percent count-rate would be shown by the scan record. When more colors are used, it will be possible to record more information on in vivo activity. Using the color scanner, some data about activity of I^{131} in phantoms were obtained, and its adaptability for diagnostic use was tested. (A.G.W.)

30110 A NEW METHOD OF RADIOISOTOPE SCANNING. EXPERIMENTAL AND CLINICAL STUDIES OF LAMINO-COLOR-SCINTISCANNER. A. Tominaga (Kobe Medical Coll.), T. Maeda, S. Okaya, S. Nishiyama, Y. Inoue, S. Kimura, I. Matsumoto, and M. Nishida. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 154-5(1963). (In Japanese)

Lamino-color-scanning was devised in order to resolve difficulties encountered in tumor detection using radioisotopes. Pulses arising from a couple of scintillation detectors within the interval of 1.2 msec are fed to the recorder as effective pulses. A color-scintigram is prepared by use of a color system. This device was applied to detection of

a point source of I^{131} in water and paraffin globes containing radioisotopes placed in thyroid and liver phantoms. These cold spheres were clearly detected by the laminoscintigram at various depths. The same results were obtained in detecting small tumors in thyroid and liver. In comparison with the area scanner, the sensitivity of this method is somewhat low. Therefore, a high-sensitivity detector or larger doses of radioisotope are required for compensatory purposes. (A.G.W.)

30111 A METHOD OF COLOR VISUALIZATION FOR THE ISOTOPE DISTRIBUTION IN THE BODY. A STUDY OF THE COLORSCANNING. Hirotake Kakehi (Chiba Univ.), Noboru Arimizu, Guio Uchiyama, Hidesaburo Genta, and Soichi Kubo. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 156-7(1963). (In Japanese)

The color photoscanning unit described consists of the following chief components: dark box, strobo-tube or xenon gas discharge tube and its lighting unit, color filter or color reflector and its driving unit, 35 mm color film or color printing papers. These are attached to the conventional photoscintiscanner. The image obtained by color scanning can be recorded on the 35 mm color film slides. The isoresponse curve can be delineated in the striped colors, corresponding to the intensity of the radioactivity distributed in the organs. The slight changes in the count rate can be obtained in the color change, and can be easily visualized in the scanning image. In applying the apparatus in scanning, the movement of the color reflector is delayed compared with the change of the real count rate because of the time lag of the rate meter. Accordingly, in the conventional method of scanning by moving the detector back and forth, a discrepancy of colors in the returning direction is produced. To improve this, it is necessary to shorten the time constant of the rate meter within the limit of stabilized colors, and to perform no return, but arrange a one-way scanning. The color filter control can be regulated by the time between count-pulses or by the count in each certain second, instead of the count rate, to get rid of this lag. Color printing paper can be used to shorten the time till the 35 mm color film is developed. Further research is being made to improve the colorscanning method. (A.G.W.)

30112 CLINICAL APPLICATIONS OF MULTI-NUCLIDES SCINTIGRAM. 1ST REPORT: ITS CLINICAL SIGNIFICANCE. Kin-ichi Hisada, Tatsunosuke Hiraki, and Hiroshi Kawanishi (Kanazawa Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 158-60(1963). (In Japanese)

A system was devised, which is intended to facilitate tumor detection by scanning for two or more radionuclides at the same time. A color scintigram is obtained in which each color corresponds to the γ spectrum of a different nuclide. In the experiment described, 3-4 μC/kg of Au^{198} colloid for scanning the liver and 10 μC/kg of Hg^{203} neohydrin for scanning the kidney were injected intravenously almost at the same time. The machine used was a Shimadzu scintiscanner including a NaI(Tl) crystal, a medical spectrometer, a contrastor, and focusing collimators with 19 and 37 holes. Scanning was started about 2 hr after the isotope injections. Dot scanning with exchange of black and red carbon papers was used in the first trial. A specially designed multi-nuclides scintigram system will be constructed in the near future. Three cases in which the system was used in tumor detection are discussed briefly. The system is expected to be most valuable in examination of the upper abdomen. (A.G.W.)

30113 X-RAY SPECTROCHEMICAL ANALYSIS USING Pm-147 BETA-RAY SOURCE. Shigemasa Enomoto and Chizuo Mori (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 161-3(1963). (In Japanese)

The suitability of Pm^{147} beta emitter for the x-ray spectrochemical analysis, with reference to analyzing binary alloys and measuring thickness of coating materials, was studied experimentally. The radioactive promethium, Pm^{147}, produced from fission products of U-235 has a half life of 2.6 years and emits beta rays of maximum energy 223 kev. To make the Pm^{147} source used, a solution of $PmCl_3$ in hydrochloric acid was repeatedly put on a mylar sheet 0.025 mm thick and dried with an infrared lamp. Then the source was covered with a mylar film 0.005 mm thick. A part of the beta rays scattered by the specimen were removed by absorption with a mylar sheet of thickness nearly equal to the maximum range of the beta radiations. The x rays produced in the specimen were observed by an x ray detector such as a proportional counter or scintillation counter. The proportional counter used was a gas (Ar 90%$-CH_4$ 10%) flow type and had a diameter of 44 mm. The scintillation counter consisted of a photomultiplier (Toshiba 7309) and a NaI crystal, 7 mm thick and 25.4 mm in diameter, covered by a Be foil 0.2 mm thick as a window. The experiment was performed with source-to-specimen distance of 25 mm and specimen-to-detector window distance of 80 mm, for the analysis of binary alloys of Al$-$Cu, Cu$-$Zn, and Cu$-$Sn, and for thickness measurements of coating materials of Cr on Cu, and Au on Cu by means of the selector counting method. Agreement between the experimental results and theoretical calculations was fairly satisfactory. (JAIF)

30114 FLUORESCENT X-RAY EXCITATION BY RI. RADIATION AND ITS MEASUREMENT. Hiroshi Imamura, Kaoru Uchida, and Hiroshi Tominaga (Ube Industries, Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 164-6(1963). (In Japanese)

For the excitation and measurement of fluorescent x rays in the light elements, some precautions are necessary which are different from those required for heavier elements. A measuring box was devised in which a radioisotope source and a sample target were placed and He gas was flowed to lessen absorption loss of radiation (primary and secondary). The bottom opening facing the sample was jointed to the side window (Mylar) of a proportional counter, which is a PR gas flow type cylindrical counter having good energy resolution. In order to study relative efficiency of characteristic x-ray emission from the target elements Mg(12) to Ni(28), tritium sources (H^3 + Zr, H^3 + Ti), an alpha source (Po^{210}), and samples of simple substances or compounds such as oxide or carbonate were used. Then using the pulse height analyzer, each K x ray in the pulse height channel corresponding to its photopeak was counted. Thus the excitation characteristics for each radioactive source were determined. For the selective excitation of K, Ca, and Sc, a H + Ti source is suitable, while an alpha source is the most fitting for excitation of the lower-Z elements. When higher-Z elements exist in the mixed sample an α source is especially suitable as it excites the lower-Z element more intensely than the higher-Z element. Lastly, x-ray excitation with radioactive sources was applied to the quantitative analysis of cement raw mix (Al_2O_3, SiO_2, CaO, Fe_2O_3), and better results than those with conventional x-ray fluorescence spectrometry were obtained. (A.G.W.)

30115 THE SENSITIVITY IMPROVEMENT IN THE APPLICATIONS OF BETA-RAYS BACKSCATTERING BY

THE ENERGY DISCRIMINATION METHOD. Shigemasa Enomoto and Tomihiko Furuta (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 167-9(1963). (In Japanese)

A method for sensitivity improvement in the analytical applications of beta-ray backscattering is described. The method involves discrimination between the energies of backscattered beta rays by using a pulse height analyzing technique. The complex characteristics of beta-ray backscattering require that quantitative response be determined experimentally. The effects of the observed angle and specimen atomic number on the backscattering intensity and energy spectrum are experimentally found for the case of P^{32} or $Sr^{90}-Y^{90}$ beta-ray sources, using an anthracene scintillation counter following a 256 multichannel energy spectrometer. The pulse height response and resolution power of the counter, using an anthracene scintillator of 20 mm in thickness and 25.4 mm in diameter, are determined for beta-ray energy up to about 2 Mev, by utilizing the beta-ray spectrometer installed in the Institute. The intensity and energy spectrum of the backscattered beta rays depend strongly on the observed angle, and both the intensity and the average energy of the backscattered beta rays increase with specimen atomic number. The results obtained agreed with the qualitative interpretation by Seliger on the basis of multiple scattering. The analytical works are performed by the pulse height discrimination method to advantage for the component analysis of binary alloys, Cu–Sn or Sn–Pb, a powder mixture, TiC–WC, and for determining the concentration of $AgNO_3$, $CdCl_2$, KI, or $BaCl_2$ in aqueous solutions. In such applications a $Sr^{90}-Y^{90}$ beta-ray source and the anthracene counter are arranged to eliminate direct radiation from the source by appropriate shielding. The sensitivity of the measurements increases with the discriminating energy of backscattered beta rays, and is similar to the value obtained by the filter method. In the case of this method some consideration for the source activity effect on measurement error is made. (JAIF)

30116 14 Mev NEUTRON ACTIVATION ANALYSIS USING A NEW ANALYTICAL INSTRUMENT. Isao Fujii and Haruo Muto (Tokyo Shibaura Electric Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 170-2(1963). (In Japanese)

Application of a new analytical instrument using a 14-Mev neutron generator for industrial purposes is described. The instrument used is made up of three parts: a 14-Mev neutron generator (10^{10} neutron/sec), an automatic control system, and a system of measurement. The neutron generator is a Cockcroft-Walton type accelerator and the automatic control system is equipped with sample transfer system and a C-R neutron monitoring system. The instrument is applicable to the nondestructive and rapid determination of oxygen in the metallic samples such as zircaloy, stainless steel, copper, iron, molybdenum, and tungsten. The precision of the analytical results made possible by this analytical instrument is ±5% at an oxygen level of 100 ~ 3000 ppm. The limit of determination is about 10 ppm of oxygen. The analyses of three samples are normally made in 1.0 minute. (JAIF)

30117 ACTIVATION ANALYSIS OF SODIUM AND POTASSIUM IN BIOLOGICAL MATERIAL. Reiji Hori (Toyama Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 173-5(1963). (In Japanese)

The sodium and potassium contents of unfertilized and fertilized eggs of sea-urchin were estimated by activation analysis. The dry matter of the eggs was ashed (390–400°C) and irradiated in JRR-I reactor (neutron flux; 3×10^{11} n/cm^2 sec, 2–4 hr). Na^{24} and K^{42} in the irradiated sample were separated. The respective amounts of sodium and of potassium were determined by comparison of gamma-ray spectrograms of standard samples. In the unfertilized eggs, the concentration of sodium was very low, being approximately ten per cent of potassium. In the case of fertilized eggs, both ions increased. The increase of sodium was greater than that of potassium, and the ratio of sodium to potassium was changed from 11.2 to 8.2. (JAIF)

30118 DETERMINATION OF IMPURITIES IN THE PURE RARE EARTHS BY RADIOACTIVATION ANALYSIS. Toshi Kawashima (Electrical Communication Lab., Tokyo). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 176-8(1963). (In Japanese)

Samples of rare earth oxides were irradiated for 1-5 hr in Japan Research Reactor-1 (3×10^{11} n/cm^2 sec) in the form of solutions impregnated in filter paper. The filter paper was wrapped in polyethylene envelopes. Gamma spectra for the irradiated samples were recorded with the Toshiba Model EDS-34202 multichannel pulse height analyzer. Impurity content of the samples was determined by the comparator method. Results are shown in a table and are compared with results obtained by emission spectrometry. Values for Eu in Gd and Dy in Y determined by activation techniques and emission spectrometry differ by a factor of ~5. (A.G.W.)

30119 ACTIVATION ANALYSIS OF OXYGEN BY MEANS OF (γ,n) NUCLEAR REACTION. Masatoshi Kobayashi, Teruko Sawai, Sumiko Nagatsuka, and Sho Maeda (Tokyo Metropolitan Isotope Center). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 179-81(1963). (In Japanese)

Results of a study of the activation analysis for oxygen of pure Al ingot or oxide film on the ingot are presented. A linear accelerator was used, which gave an x-ray dose rate of about 10^6 r/min. One-minute irradiation of the Al samples gave a γ-ray spectrum in which peaks were seen at 0.51, 0.84, 1.02, and 1.78 Mev. The nuclear reactions corresponding to the peaks are listed. Unless there is an interfering nuclear reaction, less than 1 ppm of oxygen can be determined by measurement of the gross or total activity. In this case it was only possible to determine 20 ppm. Relative activities of various elements at fixed bombarding energies were studied by using a 31-Mev betatron. It was concluded the higher energies gave better results in the oxygen determination. (A.G.W.)

30120 RADIOACTIVATION OF ELEMENTS BY USE OF PILE NEUTRONS. THE EXTENT OF THE FORMATION OF SHORT-LIVED γ ACTIVE NUCLIDES. Minoru Okada (Government Chemical Industrial Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 182-3(1963). (In Japanese)

Samples of some elements were irradiated with pile neutrons, the cadmium ratio of which was 3. The emission rate of the abundant γ ray of each nuclide formed was measured by the use of a 256-channel γ scintillation spectrometer. The emission rate was then normalized for the following conditions: the weight of element used = 1 μg, neutron flux density = 10^{11} n/cm^2 sec^1, irradiation time = $\mathcal{T}$, where $\mathcal{T}$ is the half life of a nuclide formed. The normalized emission rate is defined as "{(counts collected during a counting time lying from $\mathcal{T}$ sec after irradiation till 2 sec after irradiation)/(counting time of $\mathcal{T}$)/(photopeak effi-

ciency)". Observed were 36 nuclides with half lives ranging from 1 sec to 5 min. The coefficient of variation of observations for a few nuclides was found to be 50 to 100%. (JAIF)

30121 THE DETERMINATION OF TRACE ELEMENTS IN KOREAN SCHINSENG RADIX BY RADIOACTIVATION ANALYSIS. J. Pijck (Univ. of Ghent), M. J. Chun, J. H. Park, and J. I. Kim. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 184-90(1963). (In English)

Trace concentrations of Mn, V, Cu, Co, and As were determined in different species of Korean Schinseng roots by radioactivation analysis. Manganese was isolated as MnO_2 by precipitation. Yield determination was made by the sodium bismuthate precipitation method. Vanadium was selectively extracted as cupferron complex in isopropylether. Yield was determined by the ferrous ammonium sulfate method. Copper was isolated by extraction with cupferron-isopropylether. Cobalt was separated from the bulk material by α-nitroso-β-naphthol extraction. Yield determination for copper was made by a titrimetric method, and a long-lived tracer was added for cobalt recovery determination. Arsenic was precipitated as element, distilled in reductive medium and again precipitated. The final precipitate was used for chemical yield determination. It was found that Buyo Schinseng contained 25.9 ppm of Mn and 0.023 ppm of V, Kumsan Schinseng contained 19.0 ppm of Mn, 0.0202 ppm of V, 7.10 ppm of Cu, 0.061 ppm of Co, and 0.44 ppm of As, Kanghua Schinseng 8.00 ppm of Cu and 0.057 ppm of Co, and Poongki Schinseng 0.25 ppm of As. It appears that the results are reproducible within the limits of the method. They differ slightly from one species to another. (JAIF)

30122 APPLICATION OF A LARGE ACCELERATOR TO PRODUCTION OF IRRADIATED POLYETHYLENE PRODUCTS. Y. Tsuji, M. Kawashima, and R. Aihara (Sumitomo Electric Industries Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 191-3(1963). (In Japanese)

Work on the development of products of irradiated polyethylene and their applications is reported. A so-called NS-type electron accelerator with a power of 6 kw was used to irradiate polyethylene with $10^{12}-10^{13}$ electrons/sec cm^2. It is planned to increase the electron beam current by five times the present volume and spread the scanning width to one meter from the present half a meter. The high cost of accelerators and the duty cycle of a facility are considered from the standpoint of economic evaluation of an irradiation facility. Increasing the power of an accelerator by five times doubles the cost. The best way to reduce the cost of the products is to decrease the preparation time (now 40-50%) of materials and installations and decrease shutdown time for repairs. (A.G.W.)

30123 25 Mev ELECTRON LINEAR ACCELERATOR. H. Hatano, T. Okada, K. Oshima, N. Shigemura, and T. Unno (Tokyo Shibaura Electric Co. Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 194-6(1963). (In Japanese)

An electron linear accelerator that can produce electron energy over 25 Mev was made by Toshiba. Use of $2\pi/3$ mode accelerator waveguide eliminates the pulse-shortening phenomena completely. The length of the buncher, which is as short as three free space wavelengths, improves the conversion efficiency. A tantalum disk heated by bombardment of electrons is used as cathode in the electron gun. The heating is effected by electrons emitted from a tungsten filament. The electron beam is homogenous and its diameter is small. The electron emission from the cathode can be varied by changing the voltage of bombardment. As the space between the tungsten filament and the cathode disk is designed to work under space-charge limited conditions, fluctuations of filament voltage have little effect on the temperature of the cathode disk and the electron beam is kept very stable. Stability of a few parts per million is obtained by using a travelling wave tube, 3W20, as r-f oscillator with a transmission type cavity resonator in its feedback loop. The frequency of the oscillator is 2810 Mc. The continuous power output of the tube is rated at 4 watts. A pulsed travelling wave tube, 3W80, is used as amplifier and produces r-f pulses of 10 μsec with peak power up to 500 watts. The tube, 3W80, is triggered simultaneously with the main modulator and its power output is supplied to two klystrons, M-4614. The r-f power output is 5Mw from each of the two accelerator waveguide sections, each of which is about 180 cm long. Characteristics of the accelerator are as follows: Electron energy, 4 to 25 Mev; Peak current for 3.5 μsec pulse, 400 ma, maximum; Pulse repetition rate, 1 to 360 pps and single pulse; Pulse sidth, 0.3, 0.6, 1.2, 2.5, 5.0 μsec. (JAIF)

30124 PHOTOGRAPHIC MEASUREMENTS OF THE ENERGY SPECTRUM OF ELECTRON BEAM FROM VAN DE GRAAFF ELECTRON ACCELERATOR. Lien-sheng Chuang (Chung Chi Coll., Hong Kong). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 197(1963). (In English)

A photographic method was used to measure the relative intensity as a function of energy of the electron beam from a Van de Graaff accelerator. The film used was Kodak personal monitoring film Type 2, which is particularly sensitive to electrons and x rays, with the maximum sensitivity at 0.1 Mev. The film was covered by stepwise aluminum foils as an electron absorber. The thickness of the foils corresponds to the ranges of the electrons. All of the electrons with range less than the thickness of the foils will be stopped by the foils and leave the film unexposed. A mechanical shutter was used between the beam and the film to control the exposure time. The film was developed following the standard dark-room procedure. The blackness of the film was read by an optical densitometer. The result expressed by a differentiated curve is given. It is obvious that for accurate experiments, the spectrum should be used. (JAIF)

30125 NEUTRON YIELD BY ORC ELECTRON LINEAR ACCELERATOR. Shigeru Okabe, Kyue Fukuda, Tatsuo Tabata, Kunihiko Tsumori, Shigeki Nakamura, and Toshio Azuma (Radiation Center, Osaka Prefecture). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 198-200(1963). (In Japanese)

The neutron yields from the thick targets of uranium, bismuth, mercury, and lead in a 15-Mev electron linear accelerator were investigated in the energy range 7.5 – 13 Mev. Neutrons were detected with a BF_3 counter surrounded by a special shielding arrangement to reduce the effect of x rays and background neutrons. The efficiency of the detector was calibrated to be 5.13×10^{-8} counts/source neutron (at 3.3 meter) by comparison with a modified Kerst method in which indium foil was used instead of rhodium. The measured neutron yields are tabulated. Distributions of thermal neutrons in the water bath were measured to find out the most effective place for the isotope production, and a ratio of the number of thermal neutrons to that of total neutrons was measured to be 5×10^{-4}. (JAIF)

30126 PRODUCTION OF Sb–Be NEUTRON SOURCE IN THE JRR-2. M. Ueno, O. Horiki, H. Tomioka, and K. Taniguchi (Japan Atomic Energy Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 201-3(1963). (In Japanese)

Sb^{124} of an Sb–Be neutron source is usually activated in the reactor, and this neutron source is used when the reactor is started up. In the JRR-2 some curies of Sb^{124} were produced by the requests for critical tests. As the fuels of the JRR-2 were changed from 20% enriched to 90%, the critical test was made again in April 1962, using an Sb–Be neutron source design and produced by the JRR-2. The following items are described: (1) estimation of quantity of Sb^{124} (produced), using Co monitor wire; (2) measurement method of the γ dose rate from large γ sources, such as Sb^{124} used in neutron sources, etc.; and (3) measurement results of neutron intensity from an Sb–Be neutron source. (JAIF)

30127 EFFECT OF NEUTRON IRRADIATION OF ZnS PHOSPHORS. Toshio Yoshida, Takeyoshi Seiyama, Shigeharu Ioshino, Yoshihiko Shono, Hitoshi Nishimura, and Takashi Oka (Radiation Center, Osaka Prefecture). Proc. Japan Conf. Radioisotpes, 5th, No. 3, 204-6(1963). (In Japanese)

The effects of neutron irradiation on luminescence and electron spin resonance of ZnS phosphors were investigated. Neutron irradiation decreased markedly the luminescence efficiency. The luminescence of a hexagonal-structure sample suffered more damage from neutron irradiation than that of a cubic-structure sample, when both of them were activated with the same amount of Cu. The damage was dependent on the amount of activator contained in samples. The luminescence emission spectrum of an unactivated sample was shifted toward longer wave lengths by irradiation. The irradiation decreased the intensity of the green emission band to a greater degree than that of the blue emission band for samples activated with Cu of 0.01 or 0.001 weight percent. No change in the spectrum was observed for samples activated with Cu of 0.5 weight percent and for a sample activated with Ag of 0.01 weight percent. An infrared light of wave length of about 0.8, 1.1, or 1.3 μ was found to quench strongly the luminescence of almost all irradiated samples. The estimated concentration of impurities ($<10^{-6}$ wt %) introduced by nuclear transmutation in phosphors is much less than the added activator or intrinsic impurity concentration. The effects of nuclear reactions may be therefore neglected. The displacement probability of an atom in ZnS was approximately estimated to be of the order of 10^{-5} on the average for fast neutron irradiation of 6.7×10^{16} nvt. Five to seven ESR signals were observed in neutron-irradiated samples. The g-value of the largest signal was 2.0027. This signal decayed under illumination with light of wave length of about 5,500 Å. The center responsible for the signal is concluded to be a hole trap of Zn-vacancy. Two other photosensitive signals appeared at g = 2.05 and g = 1.88 in some samples only under ultraviolet illumination at 77°K. The photo-insensitive signal, g = 2.01, was observed in most samples. Three other photo-insensitive signals were found in every sample. (A.G.W.)

30128 RADIATION EFFECTS IN SEMICONDUCTORS. H. Saito, M. Kitagawa, and M. Hirata (Osaka Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 207-9(1963). (In Japanese)

Radiation effects in silicon and cadmium sulfide single crystals are discussed. Specimens used were cut from n-type floating zone single crystals of silicon containing phosphorus or cleaved from single crystals of cadmium sulfide grade A supplied by Eagle Picher Co. They were irradiated with Co^{60} gamma rays or bombarded with electrons of 2 Mev from a Van de Graaff accelerator. The initial carrier concentration of the silicon samples was distributed over the range $10^{13} - 10^{15}$ electrons/cm^3, and the oxygen concentration was estimated to be of the order of 10^{16} atoms/cm^3. Temperature dependence of carrier concentration after irradiation indicated the existence of two net acceptor levels, 0.17 ev and 0.4 ev below the conduction band. The introduction rate of the deep level increased with increasing phosphorus concentration, while that of the shallow level slightly decreased with increasing phosphorus concentration. Annealing of these radiation defects in silicon crystals was studied in a temperature range of 120-180°C. Radiation damage in CdS single crystals was also studied. Several electrical properties, i.e., spectral response of photoconductivity, temperature dependence of dark conductivity, Hall coefficient, and thermal quenching of photoconductivity were measured before and after bombardment with 2-Mev electrons at 77°K. After bombardment with 4×10^5 electons/cm^2, a plot of dark conductivity against reciprocal temperature gives a linear portion, the slope of which corresponds to energy of 0.25 ev. A new photoconductivity peak was produced at about 600 mμ. A thermal quenching curve of photoconductivity indicates that the concentration of sensitizing centers localized at about 0.2 ev above the valence band decreased after annealing at room temperature. At the same time, an increase of Hall mobility was observed. Results indicate that the vacancies produced with electron bombardment decrease rapidly at room temperature. (A.G.W.)

30129 EFFECTS OF ELECTRON BOMBARDMENT ON GERMANIUM. Ryoitiro Huzimura, Yasuro Ato, and Masahiro Oisi (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 210-12(1963). (In Japanese)

Two studies of radiation effects on germanium were done. First, the effects of 1-Mev electron bombardment on conductivity of about 10 ohm-cm n-type, 1.8 ohm-cm p-type, and 40 ohm-cm undoped thin germanium single crystals were investigated. The observed initial carrier removal rates were 0.12 cm^{-1} for n-type Ge and 0.43 cm^{-1} for p-type Ge. For undoped-Ge, the increment of carriers was observed. If this increment was due to holes, the rate was 0.0045 cm^{-1} and agreed with the rate of the introduction of holes in n-type samples. The number of the displaced atoms was calculated by the use of the model of Seitz and Koehler, and the energy level scheme of the radiation-induced defects was estimated. The levels consisted of an electron trap 0.11 ev below the conduction band, a hole trap 0.10 ev above the valence band, and an acceptor level 0.29 ev above the valence band. Second, the change of electric conductivity of n-type germanium single crystals with a local irradiation by 4.2-Mev electrons and its isothermal annealing were studied. Sb-doped 2 to 3 ohm-cm and undoped about 20 ohm-cm specimens, 0.4 to 0.5 mm thick, were bombarded at about −180°C and heated at 78°C or 150°C. A linear accelerator provided bombarding electrons, about 4×10^{15}/cm^2. The conductivity of the doped sample at the exposed region showed an ordinary change with integrated flux, but at the unexposed region, it decreased after a small increment. The rate of annealing of the locally irradiated region of samples was larger than that of the uniformly irradiated region. This phenomenon was predominant in the outer area of the exposure. Application of an electric field of about 10 volts/cm seemed to affect the changes at both regions. From these results, it was concluded that some of the radiation-induced defects were mobile in the crystal over a long range. (JAIF)

30130 INDUCED CONDUCTIVITIES IN IRRADIATED POLYETHYLENE. Kichinosuke Yahagi, Kenichi Shino-

hara, Kazuo Mori, and Eiichi Fukada (Wasede Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 213-14(1963). (In Japanese)

Induced conductivities in irradiated polyethylene were observed as functions of dose rate and applied voltage. Irradiated polyethylenes were prepared with electron beams from a Van de Graaff Generator. The total doses of radiation were from about 10^7 rad to 10^8 rad. The experiments on induced conductivities were carried out under γ irradiation from Co^{60}. The γ dose rates were from about 10^2 r/hr. The samples were circular films of Marlex and Arathene 90 mm in diameter and 0.075 mm thick. Each sample was coated with silver paste and then irradiated with the electron beams. The irradiated samples were set in a vacuum vessel to minimize the effects of ionization and oxidation. The induced current of irradiated samples was not dependent on the gamma dose rate, but the samples quenched from about 100°C were dependent on the dose rates. The dark currents of the irradiated samples were slightly less than the induced currents in the irradiated samples. The absorbed currents were observed by the application of d-c voltage. These results suggest that the large number of trapped electrons in the irradiated samples liberated thermally are moved in the sample. The appreciable flows of absorbed currents in irradiated samples are due to the space charge effects of these trapped electrons in the samples. (JAIF)

30131 ELECTRIC CONDUCTION OF IRRADIATED PLASTICIZED POLYVINYLCHLORIDE. Masayuki Ieda, Ukichi Shinohara, and Masamitsu Kosaki (Nagoya Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 215-17(1963). (In Japanese)

Volume resistivity of direct-current voltage has been measured on various plasticized polyvinylchlorides (PVC), containing different kinds and concentrations of plasticizer, irradiated in an atomic pile or with γ and β rays respectively. The measurements were carried out for a long period after irradiation. From the measurements of the volume resistivity(ρ) for a year after irradiation, it was found that ρ of the plasticized PVC generally decreases with radiation dose. This is not a permanent change but recovers gradually as time passes. In some cases, ρ of the irradiated specimens still increases even at present more than a year after irradiation. This phenomenon depends slightly on the kind of plasticizer and radiation dose but mainly on the plasticizer concentration (P$\bar{L}$). The specimen with large P$\bar{L}$ shows recovery of ρ earlier than that with small P$\bar{L}$. The radioinduced changes of ρ for specimens with different thickness and the temperature dependence of ρ were investigated, in order to make clear the mechanism of the electric conduction. It is concluded that the electric conduction in irradiated PVC is ionic and the charged carriers induced are mainly H^+ or Cl^- created from decomposition of PVC with high energy radiation. The post-irradiation effect observed is explained as a diffusion phenomenon of the HCl created. (A.G.W.)

30132 ELECTRON SPIN RESONANCE STUDIES ON FREE RADICALS IN IRRADIATED POLYMERS. Hiroshi Yoshida, Koichiro Hayashi, and Seizo Okamura (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 218-20(1963). (In Japanese)

In order to investigate the physical situations of the free radicals trapped in irradiated polymers, the saturation phenomena of the electron spin resonance are examined on the radicals in polyethylene (polyphenyl type radical and alkyl type radical) and polymethylmethacrylate irradiated with 1.5-Mev electrons in vacuo at liquid nitrogen temperature. For comparison with these radicals, the stable free radical, DPPH, dispersed in polymethylmethacrylate is also examined. From the saturation curves, namely, the relations between the strength of the microwave magnetic field in the sample cavity and the resonance signal intensity, the spin-lattice relaxation time, T_1, and the spin-spin relaxation time, T_2, are calculated, and the paramagnetic relaxation mechanism of the free radicals is discussed. The dependences of T_1 and T_2 upon the temperature and the radical concentration are also observed in most cases. The DPPH case, in which DPPH molecules are homogeneously distributed, was used as an example to test the relaxation mechanism. It is concluded from this example that the relaxation mechanism of the radicals trapped in polymers is due to the dipolar interaction between radicals influenced by the internal motion of polymers. The relaxation mechanism is, therefore, analyzed at least qualitatively with the well-known Kubo-Tomita's theory, with the assumption that the internal motion is ascribed to be the single thermal-activation process. The relaxation mechanism of the radicals in irradiated polymers is observed to act also on the theory. The internal motion of polymer around the trapped radicals is not considerably different from that of ordinary undamaged region. Although the macroscopic concentration of the radicals measured from resonance signal intensity varies, the saturation behaviors are independent of the concentration in the case of the polyphenyl type radical in irradiated polyethylene and of irradiated polymethylmethacrylate. Therefore, the microscopic distribution of the radicals does not change within the range of irradiation dose. This result suggests that the radicals in irradiated polymers are trapped in radiation-induced spurs, and that the amount of the spurs increases with the irradiation dose but the radical concentration in the spurs remains unchanged. (JAIP)

30133 EFFECTS OF RADIATION ON EPOXY-COMPOUNDS. K. Manaka and T. Tomioka (Tokyo Shibaura Electric Co.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 221-2(1963). (In Japanese)

Epoxy-compounds, such as allylglycidyl ether and phenylglycidyl ether, were irradiated by Co^{60} γ rays in vacuum or in air, and changes of double bonds and epoxy groups were observed by titrations, infrared absorptions, and analysis of carbon and hydrogen contents. In quantitative analysis of double bonds, a tribromide method was used, and it was found that the double bonds of allylglycidyl ether diminished more in air than in vacuum. In quantitative analysis of epoxy groups, a hydrogen chloride-dioxane method was used and it was found that the epoxy groups did not diminish as much either in air or in vacuum. Infrared absorptions agreed with these results. In consequence, it was concluded that in graft polymerization of epoxy compounds the epoxy group remains unchanged by irradiation and their activities are also retained. (JAIF)

30134 RADIATION-INDUCED THERMOLUMINESCENCE FOR IRRADIATED POLYMERS. Yohta Nakai, Harumi Inomo, Koji Matsuda, Mitsuo Ikenaga, and Ki-ichi Kimura (Japanese Assn. for Radiation Research on Polymers). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 223-5(1963). (In Japanese)

Glow curves of radiation-induced thermoluminescence for various polymers were investigated under several conditions. Samples were irradiated at −196°C and warmed up by a heater. The luminescence from the sample was detected by a photomultiplier tube. Irradiation and measurements were carried out in air. For polypropylene, after

10^4 rad, the glow curve has peaks at –170°C and –130°C. The luminescent intensity increases with the dose. At 10^7 rad, saturation is observed, and the glow curve has one peak at –170°C. When the sample is exposed to uv or daylight after irradiation, luminescent intensity decreases. For polyethylene after various doses, the glow curves have peaks at –170°, –120°, and –40°C. Saturation is observed at 10^8 rad. Saturated hydrocarbons with the same main chain as polyethylene have glow curves of the same shape. The glow curve for polystyrene has one peak at –180°C. The glow curve for nylon has two peaks at –180° and –130°C. The maximum luminescent intensity is observed at 10^6 rad. Luminescent intensity decreases rapidly with time after irradiation. (A.G.W.)

30135 RADIATION THERMOLUMINESCENCE STUDY ON RADIATION-INDUCED SOLID STATE POLYMERIZATION OF CYCLIC MONOMERS. K. Kamada, S. Mori, K. Hayashi, Y. Nakai, and S. Okamura (Japanese Assn. for Radiation Research on Polymers). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 226-8(1963). (In Japanese)

The relationship between radiation thermoluminescence and radiation-induced post-polymerization of β-propiolactone and diketene was studied in an attempt to obtain more direct evidence for the mechanism of radiation-induced polymerization. In the case of β-propiolactone, one (–47°C) of six glow peaks behaves in coincidence with post-polymerization under the effects of dose, dose rate, irradiation temperature, storage, and illumination, and it may be concluded that an active species corresponding to this peak initiates post-polymerization in the solid phase. On the other hand, one (–175°C) of four glow peaks of diketene corresponds well to post-polymerization under conditions such as dose and storage and is considered as an active species for initiation of post-polymerization. It appears that at –196°C the active species is frozen within the monomer crystal without initiating post-polymerization, and post-polymerization takes place at the glow curve peak of –175°C observed in radiation thermoluminescence. (JAIF)

30136 THE SOLID STATE POLYMERIZATION AND COPOLYMERIZATION OF 3-HALOGENOMETHYL-3-ETHYLOXETANES. Masatoshi Miura, Takako Hirai, Toshiyuki Aoyagi, and Shunzi Kawamatsu (Hitachi Central Research Lab.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 229-31(1963). (In Japanese)

The solid state polymerization of 3-fluoromethyl-3-ethyloxetane (FEO) and of 3-chloromethyl-3-ethyloxetane (CEO) and the solid state copolymerization of FEO and CEO are investigated. FEO and CEO show very similar polymerization behaviors, though the polymerization rate of FEO is much slower than that of CEO. Initial polymerization rate, saturated polymer yield, and molecular weight of the obtained polymer are greater for slowly crystallized samples than for rapidly crystallized ones. The polymerization rate and molecular weight of polymer were found to have a maximum value at an irradiation temperature about 20°C lower than the melting point of each monomer. These observations indicate that the crystal condition of the monomer affects the solid state polymerization. From the observation of phase diagrams, mixtures of FEO, and CEO were found to be solid solutions at temperatures below the melting point over all compositions. Copolymers obtained by the irradiation of these solid solutions are of the same composition as the initial monomer mixtures. Properties of polymers were investigated. From x-ray-diffraction analyses, FEO, CEO, and copolymer have all very high crystallinity. Melting points of FEO and CEO are 129 and 105°C respectively, and copolymers also have sharp melting points. (A.G.W.)

30137 RADIATION-INDUCED POLYMERIZATION IN CRYSTAL. K. Hayashi (Japanese Assn. for Radiation Research on Polymers), M. Nishii, H. Watanabe, Y. Nakase, and S. Okamura. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 232-4(1963). (In Japanese)

Radiation-induced solid state polymerization of cyclic monomers, such as trioxane, tetroxane, β-propiolactone, and 3,3 bis(chloromethyl) oxetane was investigated. It was observed that the polymerization reaction was influenced strongly by the structure of the monomer crystal. The structure of the polymer obtained was examined by x-ray-diffraction analysis. The polymers of trioxane and tetraoxane were shown to have a three dimensionally oriented structure, and to be in helical configuration. The existence of twin crystallites was observed clearly in the polymer crystals of trioxane and 3,3-bis(chloromethyl) oxetane. Two kinds of polymers obtained from β-propiolactone and 3,3-bis(chloromethyl) oxetane were found to have the planar zig-zag configuration. These characteristic configurations of the polymer crystals are understood as effects of epitaxy of monomer crystal structure. That is, the effects of epitaxy appear most pronounced in the case of trioxane because of the symmetrical hexagonal structure of both monomer and polymer crystal. (JAIF)

30138 RADIATION-INDUCED POLYMERIZATION OF FORMALDEHYDE IN LIQUID STATE. Seizo Nakashio (Sumitomo Chemical Co., Ltd.), Kei Takahashi, and Masatsune Kondo. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 235-7(1963). (In Japanese)

Monomeric formaldehyde is rapidly polymerized by ionizing radiation, especially in the liquid state, and gives the polyoxymethylene of high molecular weight. The reaction rate itself is large but considerably different in bulk and solution systems. There is no linear relation between the polymerization rate and monomer concentration. This paper confirms these facts for solution polymerization in acetone, methylene dichloride, toluene, and isopropylbenzene. In the heterogeneous polymerization of formaldehyde the monomer is not dispersed completely enough to produce polymer particles with good reproducibility in the case of high conversions. This is due to the fact that monomer-polymer particles have a tendency to adhere to the glass surface of the reaction flask as the reaction proceeds and the reaction products can not be easily collected. This was observed in the reactions of the monomer dispersed in n-heptane and methylcyclohexane. In lower monomer concentrations the rate is relaxed in rather low conversions. Polymerization of the monomer dispersed in methylcyclohexane and n-heptane was carried out using some purified sorbitan oleates as surfactants. Polymer thus obtained was microscopically in the pearl-like form. The reaction proceeds smoothly even in high conversions and the rate is scarcely influenced by surfactant concentration in the region of 5.0–0.05%. It is concluded that the polymerization is initiated by active species directly produced in monomer particles by irradiation. Polymer particles thus obtained gradually grow up as the reaction proceeds. In the final state of conversions beyond 90%, mean polymer particle size is almost the same. In the initial state of the reaction monomer particles have dimensions reversely relative to surfactant concentration. (A.G.W.)

30139 GAMMA-RAY INDUCED COPOLYMERIZATION OF FORMALDEHYDE. Hitoshi Yamaoka (Kyoto Univ.),

Koichiro Hayashi, and Seizo Okamura. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 238-9(1963). (In Japanese)

The copolymerization of formaldehyde with vinyl monomers and other aldehydes was studied. α-Methylstyrene (α-MeSt), p-methoxystyrene (p-MeOSt), methylmethacrylate (MMA), and acrylonitrile (AN) were chosen as comonomers. The copolymerizations with α-MeSt and p-MeOSt were carried out in toluene solution. It was found that α-MeSt copolymerized a little but p-MeOSt did not, and that the rate of copolymerization with α-MeSt decreased remarkably with the increase of monomer concentration of α-MeSt. The rate of thermal degradation of copolymer with α-MeSt in air was the same as that of polyoxymethylene, but the rate measured in nitrogen was observed to be smaller than polyoxymethylene. The copolymerizations with MMA and AN were carried out in diethyl ether solution. The infrared spectra of the copolymers showed the absorption of a carbonyl group. However, the polymer composition determined by carbon-hydrogen analysis did not show appreciable difference between formaldehyde homopolymer and the copolymer at 50 : 50 monomer molar ratio. Accordingly it might be supposed that MMA added only at the chain ends, or else the amount of MMA was very small. A similar result was obtained in the case of the copolymerization with AN. Copolymerizations were also studied with acetaldehyde and n-butyraldehyde. From infrared spectra and carbon-hydrogen analyses of the copolymers, it was found that both aldehydes copolymerized easier than vinyl monomers. The crystallinity, melting point, and thermal stability of the copolymers decreased in proportion to an increase of comonomer concentration in polymers. (JAIF)

30140 RADIATION-INDUCED POLYMERIZATION OF KETENE AND ITS DERIVATIVES. K. Fujiwara, K. Hayashi, and S. Okamura (Japanese Assn. for Radiation Research on Polymers). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 240-2(1963). (In Japanese)

The polymerization reaction is considered here to take place at two different double bonds, either by opening of $\rangle C=C\langle$ ethylenic double bond or by that of $\rangle C=O$ carbonyl double bond. The former produces the polyketone type polymer and the latter, the polyacetal type polymer. When the $\rangle C=C\langle$ and $\rangle C=O$ bonds react in the alternative addition, the polyester type polymer is expected. Monomeric ketene was prepared by the pyrolysis of acetone using a ketene generator. Dimethylketene was synthesized by the thermal decomposition of demethylmalonic anhydride. The polymerizations were carried out under the irradiation of Co^{60} γ rays at temperatures from –45 to –196°C in liquid and solid states. Ketene polymerized by irradiation in the liquid phase with an activation energy of 2.4 kcal/mole and gave a polyester type polymers (Polymer III), while in solid phase polymerized with activation energy of –0.13 kcal/mole and gave a mixture of polyester type and polyketone type polymers. In the liquid phase, the initial rates of polymerization were found to be directly proportional to the dose rates. The polymer obtained was brown powder. Polymers formed in liquid state melted at about 60°C, but almost all of the polymers formed in solid state could not melt below 200°C. The former had the intrinsic viscosity number of 0.05 to 0.08 in m-cresol solution at 30°C. Both polymers were recognized to have a certain crystalline character. Dimethylketene polymerized to a polyacetal type polymer both in liquid and solid phases, and the polymers had a crystalline character. The polymer was white powder and melted at 130 to 145°C. These polymers were recognized to have a certain crystalline character, but were very unstable even at room temperature. Dimethylketene also copolymerized with aldehydes, methylformate, and ethylenimine. Diketene polymerized only in solid state forming a polyester type polymer. In liquid phase, however, it copolymerized with vinyl-monomers such as acrylonitrile at the place of the $\rangle C=C\langle$ double bond. Comparison of these results with those of catalytic polymerization, indicates that radiation-induced polymerization almost proceeded in an anionic mechanism. (JAIF)

30141 RADIATION-INDUCED POLYMERIZATION OF STYRENE OXIDE. Yoneho Tabata, Takashi Nakamura, and Hiroshi Sobue (Japanese Assn. for Radiation Research on Polymers, Tokyo). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 243-4(1963). (In Japanese)

Radiation-induced polymerization of styrene oxide is reported. It was found that ring-opening polymerization of the monomer is possible in a liquid state. Apparent activation energy was 35 kcal/mole in the case of electron irradiation and 16.5 kcal/mole in γ irradiation in the liquid phase. The polymerization was inhibited strongly by radical scavengers. It was concluded from these experimental results that the polymerization of styrene oxide would proceed via radical mechanism in the liquid state. Apparent activation energy of the polymerization in the solid state of the monomer was –0.2 kcal/mole in the temperature region –80° to –130°C, 0.5 kcal/mole in the region –150° to –196°C. (JAIF)

30142 THE ADDITION OF CYCLIC ETHERS TO TETRACHLOROETHYLENE BY THE γ-RAY IRRADIATION. Tatsuo Matsuda, Takaari Yumoto, and Kozo Iseda (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 245-7(1963). (In Japanese)

The radiation-induced addition reaction between tetrachloroethylene and cyclic ethers, tetrahydrofuran and paradioxane, was studied. In a glass ampule tetrachloroethylene and cyclic ether were placed and the ampule was deaerated, sealed, and then irradiated with gamma rays at a dose rate of 1.2 to 6.0×10^4 r/hr at room temperature. The reaction mixture was distilled to remove unchanged samples and the remainder was distilled under reduced pressure to obtain crude oil. The crude oil was redistilled precisely to separate 1 : 1 adduct. The amount of 1 : 1 adduct in the crude oil was also determined by gas chromatography measurement. In the case of tetrahydrofuran, 2-(1,1,2,2-tetrachloroethyl) tetrahydrofuran was found to be the main product. In the case of paradioxane, 2-(1,2,2-trichlorovinyl) paradioxane and 2-(1,1,2,2-tetrachloroethyl) paradioxane were the products, with the former the dominant product. The physical properties of these products are summarized in a table. The effects of the reaction conditions on the conversion, based on the total amount of tetrachloroethylene used, and the yield of 1 : 1 adduct, based on the amount of tetrachloroethylene consumed, were studied. In the case of tetrahydrofuran, the yield of 1 : 1 product was 75-80%. There was a tendency toward decrease as irradiation dose increased. G-value of the formation of 1 : 1 product was about 900. In the case of paradioxane, the rate of conversion was much smaller than that in the case of tetrahydrofuran. 2-(1,2,2-Trichlorovinyl) paradioxane and 2-(1,1,2,2-tetrachloroethyl) paradioxane were obtained in 45-58% and 9-20% yields respectively. The optimum mol ratio of tetrachloroethylene to cyclic ether was found to be 1 : 4. (A.G.W.)

30143 GAMMA RADIOLYSIS OF AMINO ACID AND ENZYME PROTEIN IN DRY POWDER AND IN SOLUTION.

Shigetake Ganno, Akira Ohara, Soji Rokushika, Masao Murano, and Hiroyuki Hatano (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 248-50(1963). (In Japanese)

After exposure to γ irradiation as dry powder, twenty amino acids were mixed together and survival amino acids were determined automatically by a new amino acid analyzer, which was designed by H. Hatano and his co-workers in Kyoto University and Hitachi Ltd. When the radiation sensitivity of the amino acids in the state of dry powder was determined, it was found that histidine and tryptophan were relatively radioresistant, and threonine and cystine were radiosensitive under the same condition. In aqueous solution, twenty amino acids were irradiated by γ rays to produce carbonyl compounds such as corresponding keto acids or aldehydes. Survival amino acids were also determined by the amino acid analyzer. The radioresistance of tyrosine, contrary to phenylalanine, was due to the resonance structure of the aromatic ring. Trystophan was also found to be radioresistant. The radiosensitivity of sulfur-containing amino acids was observed in methionine. Constituent amino acids of protein showed different radiolytic behaviors from the above free amino acids. A specimen of bacterial proteinase was exposed to γ irradiation, and residual proteinous substances were precipitated by addition of a trichloroacetic acid reagent. The precipitate was hydrolyzed according to a usual method and the resultant hydrolysate was subjected to automatic determination of amino acids by the amino acid analyzer. Tyrosine, which is most radioresistant in the state of dry powder, was found to be most radiosensitive when irradiated as one of constituent amino acids of protein. In the dry state no appreciable decrease of the amount of amino acid content of the bacterial proteinase was found after doses of γ irradiation from 10^3 r to 10^8 r. However, the irradiated enzyme had lost about 50 per cent of its proteolytic activity by a dose of 10^7 r. This fact suggests that some conformational change, rather than the chemical structure of the protein, caused the damage to enzyme protein. Electron spin resonance spectra of free radicals produced from the irradiated enzyme were detected by an electron spin resonance spectrometer. (JAIF)

30144 THE IRRADIATED POLYOLEFIN WIRE, CABLE, AND TUBING INDUSTRY. Ernest J. Henley (Stevens Inst. of Tech.), David Sahud, J. Cohen, and R. Glaubach. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 251-9(1963). (In English)

The effects of radiation on properties of polyethylene are reviewed. Products made of irradiated polymers are listed. Wire, cable, and shrinkable tubing are now available. Formulations, manufacturing procedures, product specifications, comparison of competing products, and the future of the industry are discussed. (A.G.W.)

30145 TRITIUM LABELING OF ASPARTIC ACID. Tadao Takahashi, Teruhiko Meshi, Yoshishige Sato, and Norio Sugimoto (Tanabe Seiyaku Co., Ltd., Osaka). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 260-1(1963). (In Japanese)

In order to introduce tritium into aspartic acid, a gas exposure method, an exchange method, a chemical method, and a biochemical method were employed. DL-Aspartic acid-H^3 with a specific activity of 87 μC/mg was obtained in a radiochemical yield of 4.9% by reducing oxaloacetic acid with tritium gas in a mixture of aqueous ammonia and alcohol. L-Aspartic acid-H^3 with a specific activity of 62.8 μC/mg was prepared biochemically from fumaric acid-H^3 obtained by half hydrogenation of acetylene dicarboxylic acid with tritium gas. The gas exposure method and the exchange method yielded only specific activities lower than 1 μC/mg. (JAIF)

30146 RECOIL LABELING OF ORGANIC COMPOUNDS. Shigeru Oae (Osaka City Univ.), Masayuki Hamada, Yoshio Otsuji, Naomichi Furukawa, and Eiko Iwamoto. Proc. Japan Conf. Radioisotopes, 5th, No. 3, 262-4(1963). (In Japanese)

The results of C^{14}-labeling under neutron irradiation of two groups of compounds are reported: (1) naphthalene, phenanthrene, and anthracene in an attempt to determine whether or not high energy C^{14} fragments formed by nuclear recoil would favor or discriminate against any particular position in product formations; (2) pseudoephedrine, 2-amino-pyrimidine, and 3,6-dihydroxypyridazine as complex nitrogen-containing compounds. These samples were irradiated with thermal neutrons obtained from a pile. To determine the radiochemical yields and the relative ratios of the C^{14} distributions in the respective compounds, the samples were purified radiochemically and were degraded chemically. The results deduced from the experimental data are the following: (1) higher distribution of C^{14} was found in the positions where the localizations of electrons are known to be higher; (2) the re-entry of C^{14} into angular positions was very small; (3) the difference of phase affected the yield but not the distribution of C^{14} in the products; (4) the relatively complex compounds could be labeled directly by this method. (A.G.W.)

30147 A FUNDAMENTAL STUDY IN NEUTRON RADIOGRAPHY. Masatoshi Kabayashi and Kiyoshi Nakajima (Tokyo Metropolitan Isotope Center). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 265-7(1963). (In Japanese)

A preliminary study on the fundamental aspects of use of neutron radiography for nondestructive inspection of materials was carried out. The yield of thermal neutrons was measured first by using a 20-mC Ra–α–Be neutron source and a BF_3 counter, which showed the maximum yield of the thermal neutron flux at 5 to 7 cm thickness of paraffin. The absorption curves determined for several materials such as iron, lead, and cadmium showed good agreement with those obtained by calculations using thermal cross sections, whereas the coefficient obtained by water was much lower than what was expected. The radiography was tried by using a cyclotron in which the neutrons accelerated up to 3.5 Mev bombarded a beryllium target. This resulted in the production of fast neutrons by the nuclear reaction $Be^9 + H^2 \rightarrow n + B^{10}$. These fast neutrons were moderated in a paraffin layer 8 cm thick, which permitted use of a thermal neutron flux of 7×10^5 n/cm^2 sec at 50 cm from the target. The use of an intensifying screen composed of double layers of ZnS scintillator and boric acid showed a remarkable blackening effect on the industrial x-ray film. However, without the intensifying screen or with a ZnS scintillator screen only, the blackening of the film was observed. It was due to the presence of an intense gamma-ray flux produced by the nuclear reaction or the collision of the neutron. It was found that a film received about 0.5 to 1 roentgens of gamma radiation during an exposure for neutrons. In order to establish a simple and practical way of neutron radiography, the "image transfer" method was investigated by using a nuclear reactor. An indium plate, 0.35 mm thick, was irradiated for 10 minutes in a neutron flux of 10^6 n/cm^2 sec of a thermal column, which produced a radioactivity of about 2×10^4 dps/cm^2 by a nuclear reaction $^{115}In(n,\gamma)^{116m}In$. An exposure

of 3 hours after the irradiation gave a good resolution on a developed x-ray film. (A.G.W.)

30148 THICKNESS MEASUREMENT ON POLYMER THIN FILMS WITH THE USE OF A SILICON JUNCTION ALPHA-PARTICLE DETECTOR. Kazuo Teranishi (Hitachi Central Research Lab., Tokyo). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 268-70(1963). (In Japanese)

Thickness measurement of polymer thin film by the α absorption method in air was investigated. Po^{210} was used as an α source, and a solid state detector with good energy resolution was used with a bias of 35 v as a detector of α-particles. The output of a detector was fed to a single channel pulse height analyzer. The base line of the pulse height analyzer was scanned automatically at a speed of 20 min within a range of 100 v, and the resultant spectra were recorded on the chart by using a rate meter. The distance from the source to the detector was 9 mm. The several samples were in turn inserted between the source and the detector, and the calibration curve for sample thickness was obtained, using the measured results of the energy loss in air based on the reduction in pulse height spectra. Used samples were Tetoron films with various thickness. Thicknesses from 0.9 to 2.1 mg/cm^2 were measured. Accuracy was about 0.04 mg/cm^2. Time for measurements was less than 10 minutes. Owing to the absorption by air, the effective α-particle energy in the measuring system was reduced. After correction for absorption by air, agreement of the experimental α-particle range with the theoretical one was fairly good. (A.G.W.)

30149 CONSIDERATION ON THE WEAKENING PHENOMENON OF FILAMENT USED FOR ELECTRIC LAMPS BY P-32 TRACER TECHNIQUE. Minoru Ozasa, Shojiro Ichikawa, Rikusei Kohara, Akira Yoshimi, and Jiro Maruichi (Matsushita Electronics Corp.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 271-3(1963). (In Japanese)

The filament of high-wattage electric lamps using red phosphorus as getter has a tendency to down at the end parts. According to the metallurgical study, the phenomenon seems to be caused by phosphorus. Hence an attempt was made to trace the behavior of a small amount of phosphorus on the filament with the aid of radioactive red phosphorus, P^{32}, in order to make clear the role of phosphorus in the weakening phenomenon by comparing the results with the metallurgical observation. Radioactive red phosphorus obtained as an irradiated unit was refined chemically, powdered, and spread on the filaments in the form of an alcoholic suspension. The test lamps using these filaments were made and then running tests were carried out under several conditions. After running tests the filaments were taken out and the phosphorus remaining on the filaments was determined by beta counting. The distribution of phosphorus on the filaments was observed by autoradiography. Before running tests, 247 ± 57 μg of phosphorus existed over a whole filament, although its distribution was not necessarily uniform. Most of the phosphorus vaporized from the filament during the running test. However, 0.05 to 0.5 μg of phosphorus remained at the end parts of the filament even after 600 min of running time. The remaining phosphorus is due to the temperature of the end parts of the filament, which is about 1000°C lower than that of the central part (about 2500°C). In addition, it was confirmed by microautoradiography that phosphorus diffused into the filament at those parts. According to the metallurgical study, reductive non-metallic elements such as phosphorus affect the recrystallization of tungsten crystals by reducing the doping materials. From the microphotographic observation of those parts, it was found that the fiber structure changed completely to the block structure after running, which fact causes the filament to weaken. Further experimental results show that such a structure appears at a temperature higher than 1200°C when the filament contacts with phosphorus. It is thus presumed that the weakening phenomenon at the end parts of the filament will be caused by phosphorus remaining at those parts. Therefore, when phosphorus is spread only near the central part of the filament, where the temperature is high enough to vaporize phosphorus rapidly, phosphorus was not found anywhere on the filament after running, and the change of crystal structure was not recognized. (JAIF)

30150 A NEW TRACE ANALYSIS USING RADIOACTIVE ISOTOPE AND DETERMINATION OF TRACES OF MERCURY IN RICE. Nobuo Suziki (Tohoku Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 274-6(1963). (In Japanese)

Some new types of trace analysis involving radioisotopes and an isotope dilution principle are proposed. The new methods are classified as an isotopic exchange analysis and two types of quantitative isotope dilution analysis, a known amount extraction method (direct method) and a carrier amount variation method (indirect method). These methods are briefly explained with experimental examples. The isotope dilution method was applied to the separation and determination of Hg in rice using Hg^{203}. It was found that Hg content in unpolished rice is slightly higher than that in polished rice, and that Hg content is distinctly increased when rice plants are sprayed with mercurials. It seems likely that Hg content is related to Hg concentration of mercurials sprayed. (A.G.W.)

30151 A TRACER STUDY ON THE SOLID SOLUBILITY OF NICKEL IN SILICON. Masayuki Yoshida, Hiroyuki Aoki, Yoichiro Yamaguchi, and Hisaaki Okazaki (Nippon Telegraph and Telephone Public Corp., Tokyo). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 277-9(1963). (In Japanese)

Experiments on the Ni–Si system indicate that nickel atoms are not distributed uniformly in the base material of silicon. The concentration of nickel is very low near the surface, gradually increasing and finally reaching a constant value near the center of the specimen. For this reason, the standard technique cannot be used to determine solid solubility of Ni in Si. The present technique based on the surface counting method provides a means of determination of solid solubility by using the value at the central region of a specimen. The surface activity S(X) depends on the concentration C(X) as follows: $S(X) = \lambda \int_0^R C(X + x)f(x)dx$, where the symbols are the same as those used by C.A. Mackliet (Phys. Rev. 109: 1964(1958)). In the system of nickel and silicon, nickel atoms are distributed uniformly in the central region, so that C(X + x) may be approximately expressed by C(X) in this region. Therefore, $S(X) = \lambda\, C(X) \int_0^R f(x)dx$. Then, it is clear that the nickel concentration C(X) in the central region is calculated with the surface activity S(X), if the integral $\int_0^R f(x)dx$ could be experimentally estimated. In order to obtain the value of $\int_0^R f(x)dx$, the absorption of β particles from Ni^{63} by the silicon layer was measured. A Ni^{63} source was prepared as follows: 0.01 ml of dilute $^*NiCl_2$ solution was dropped on the flatly etched silicon surface and dried by heating with an infrared lamp. The activity of nickel tracer was counted with a 2π gas flow counter. Vacuum-deposited silicon film and aluminum foils were used as absorber. Absorber thickness is expressed in terms of the thickness

of silicon layer. The average range was estimated to be about 10 μ, and the value of the integral $\int_0^R f(x)dx$ was found to be $(1.45 \pm 0.10) \times 10^{-4}$. Then, $C(X) = (1.57 \pm 0.10) \times 10^{15}$ S(X). (JAIF)

30152 DIFFUSION OF SOLUTE WITH LOW SOLUBILITY. Shigeto Miura, Toshiro Suzuoka, Hiroshi Watanabe, and Tokutaro Hirone (Research Inst. for Iron, Steel, and other Metals, Sendai). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 280-2(1963). (In Japanese)

The diffusion of iron and cobalt in silver single crystals was studied with the lathe-sectioning technique. The deposited layer of iron (Fe^{59}) or cobalt (Co^{60}) on the surface of silver specimens was within one atomic layer in thickness. With this small amount of the diffusing element, it was observed that the anomaly near the surface became negligible and the concentration-depth curves were almost normal throughout the whole range of the penetration depths. It was observed that the diffusion coefficient at a given temperature showed a dependence on the diffusion time which never occurs in usual cases. In order to explain these results it was assumed that the anomaly near the surface is due to the impermeability of solute with concentrations above its solubility limit. It was also assumed that in this case the anomaly is very small and disappears at an early stage of the diffusion process because of the small amount of the diffusing element. Then the concentration profile may be almost normal but may not give the correct diffusion coefficient because of the effect of the initial impermeability, as observed. The diffusion now takes place under the condition where the solute is perfectly soluble and hence it can be described by a single diffusion coefficient D throughout the whole range of depth. In this situation the concentration can be reduced to a usual form, with the apparent diffusion coefficient D_{app} which is related to the true coefficient D as follows: $D_{app} = D\,(1 + \text{const}/t)$, where t is the diffusion time. The present experimental result shows that the above relation is satisfied fairly well and that reasonable values can be obtained for the activation energy and frequency factor. (JAIF)

30153 SELF-OXIDATION REACTION OF ^{124}Sb(III). Tomihisa Kambara (Shizuoka Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 283-5(1963). (In Japanese)

It was previously found that most radioactive antimony (Sb^{124}(III) or Sb^{125}(III) in HCl solution) is converted to Sb(V)* by its own radiations. Some studies were made to clear the reaction mechanism and to find conditions that may retard the self-oxidation reaction. Hydrochloric acid solutions of Sb^{124}(III) were prepared, and these sample solutions were kept under several different conditions. The Sb^{124}(V) produced was separated and counted. For the separation of Sb^{124}(V) from Sb^{124}(III), the modified isopropylether extraction method proposed by N. A. Bonner was employed and γ rays were counted with a scintillator. The relations of Sb^{124}(V) produced and the time elapsed were investigated closely. By plotting the logarithm of Sb^{124}(III) (% unconverted) versus the time elapsed all the reactions were found to be of first-order, and the half time for the conversion was obtained. The factors that influence the reaction velocity were found to be light, temperature, and specific activity and acidity of the sample. For retarding the self-oxidation reaction, the sample should be kept in a dark place at a temperature lower than 4°C. The specific activity of the sample should be lowered if allowable and the acidity should be lower than 6 M HCl. (A.G.W.)

30154 STUDY ON THE CATALYTIC ROLE OF METAL SURFACE BY MEANS OF TRITIUM AS TRACER. Toyosaburo Takeuchi and Takeyoshi Asano (Toyama Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 286-8(1963). (In Japanese)

In order to distinguish whether hydrogen strongly or weakly adsorbed on the site of a nickel catalyst is more active for the reaction with ethylene, a modification of the differential kinetic isotope method using tritium as a tracer was devised and applied at −78°C. Hydrogen (or tritium) was adsorbed first on a reduced powdered nickel catalyst and tritium (or hydrogen) was subsequently adsorbed, then ethylene was added. After a certain time, hydrogen, ethylene, and ethane were drawn off successively from the reaction vessel and separated. The assay of tritium in every fraction of gas was made with the use of a gas counting tube. The results led to the conclusion that the hydrogen strongly adsorbed on the site is more active than the weakly adsorbed hydrogen. (JAIF)

30155 DETERMINATION OF RADIOTRACER $^{131}I^-$ AND $^{82}Br^-$ BY CHEMICAL TREATMENT IN WATER FLOW MEASUREMENT. Masao Kato, Kunitaro Kawazoe, Otomaru Sato, and Yasushi Takeuchi (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 289-90(1963). (In Japanese)

Problems in chemical separation and measurement of radiotracer I^{131} and Br^{82} in flowing water were studied. The following procedure is recommended: (1) precipitation and filtration as Ag salt under acid conditions by adding conc. H_2SO_4, carrier solution (NaI and NH_4Br), and $AgNO_3$; (2) addition of acetone to gather adhered Ag salt from the funnel and dry it; (3) solution of the precipitate in $Na_2S_2O_3$ solution with NH_4OH added; (4) γ counting by a scintillation counter. The yield of radiotracer averaged 95%. The procedure is applicable to concentrations of 0.02 to 100 $\mu C/m^3$ of water. Water samples with higher activity are measured directly by either β or γ counting. (A.G.W.)

30156 A NEW METHOD FOR DETERMINING THE U-235 ENRICHMENT OF FLAT FUEL PLATES. Jose O. Juliano and Pericles Meneses (Philippine Atomic Energy Commission, Manila). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 291-5(1963). (In English)

A non-destructive method for determining the U^{235} enrichment of aluminum-clad flat reactor fuel plates is presented. This method is based on the assignment of the 186-kev photons to the U^{235} and the 92-kev photons to the U^{238} daughter Th^{234} and U^{235}. Hence, the ratio of the relative intensities of the 186-kev to 92-kev photons emitted by the fuel plate when used with the proper equation gives the per cent U^{235} enrichment. An empirical equation was derived, which agreed very closely with experimental data. $\gamma\,186/\gamma\,92 = 24.6695\,E/(17.6215E + 100)$, where E is the enrichment of U^{235} in per cent. The values of $\gamma 186/\gamma 92$ from the equation as compared to the experimental values are given a table. A theoretical equation based on U^{235} and Th^{234} decay schemes gave for well-resolved gamma-ray intensities, $\gamma 186/\gamma 92 = 6.5870E/(0.7324E + 100)$. The method was used to analyze the Philippine open-pool reactor fuel plates. Better results can be obtained if the empirical relationship is redetermined for each particular experimental setup used. (A.G.W.)

30157 THE TECHNOLOGY OF RADIOISOTOPIC POWER. J. G. Morse (Martin Co., Nuclear Div., Baltimore). Proc. Japan Conf. Radioisotopes, 5th, No. 3, 296-302(1963). (In English)

Power systems deriving their energy from radionuclide decay have been under development for more than six years, under U. S. Atomic Energy Commission sponsorship. Called SNAP, these systems consist of large sealed sources of radioisotopes which generate heat through absorption of decay energy. Power is obtained by converting this heat into electricity using thermoelectric and thermionic devices. The physical, chemical, and nuclear characteristics of appropriate radioisotopes as they relate to the design of optimum thermoelectric generators are reviewed. The uniqueness of these power systems lies in their use of radionuclide heat and their design life-times are determined, in large part, by the decay rates of the high power density fuel materials. During the past year a number of radioisotopic power systems have proved to be practical devices for uses in remote locations. Technical considerations are described, which relate to the selection of the fuel, power density (thermal watts per cubic centimeter) of the chemical form used, operating temperatures, containment of fuel and safety of the system. (JAIF)

30158 PROCEEDINGS OF THE 5th JAPAN CONFERENCE ON RADIOISOTOPES, [MAY 21-23, 1963, TOKYO, JAPAN]. NO. 4. RESULTS FROM APPLIED RESEARCH. (Japan Atomic Industrial Forum, Inc., Tokyo). 1963. 245p.

Sixty-six articles are abstracted in NSA; abstracts were not prepared for the remaining 17. (P.C.H.)

30159 RADIOISOTOPE PRODUCTION BY 15 Mev LINAC. J. Furuta, M. Fujishiro, T. Onishi, and T. Azuma (Radiation Center of Osaka Prefecture, Sakai). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 1-2(1963). (In Japanese)

The production of radioisotopes of K, Na, Mn, As, I, Cs, La, Er, and Yb by the (n,γ) reaction was studied. Each of the nuclei produced was confirmed by both the gamma spectrum and decays of main photopeaks. Neutron flux was monitored with a thin Au foil, so as to calculate approximately the RI yields that were compared with the values derived from counter efficiencies. 0.2 to 2.0 μC radioisotopes were obtained per 1 g of the compounds of the elements with conditions of Ee = 10 to 13 Mev, 50 to 70 μa beam current, 4.5 to 5.0 μs pulse width, 80 to 100 repetition per sec and 1 hr irradiation. It was concluded that if higher power and longer irradiation are employed, radioisotopes of a few μC could be produced for these elements that have thermal cross sections of 10 barns or above and half lives of a few tenths of an hour at most. (P.C.H.)

30160 PHOTOPRODUCTION OF RADIOISOTOPES WITH 20-Mev LINEAR ELECTRON ACCELERATOR. I. METHOD OF IRRADIATION. T. Tamura, T. Kuroyanagi, and K. Tanaka (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 4-6(1963). (In Japanese)

The method of irradiation in 220-Mev linear accelerator is described. The spatial distribution of bremsstrahlung was measured by the activation of Cu wires (0.8 mm in dia) arranged appropriately with a well focused 20-Mev electron beam (4 mm in dia). Intensity of the bremsstrahlung on the front of converter decreased to half the maximum value at 5 to 7 mm in dia and 25 mm in length. The average intensity of the bremsstrahlung in this region measured by Cu activation was 5×10^6 roentgen/min at 20 Mev, 40 μ Å. The neutron flux measured by the activation of Al sample in the target position with fast and slow neutrons were 6.3×10^9 n/cm^2/sec and 3.2×10^8 n/cm^2/sec respectively at 20 Mev, 40 μ Å. It was noted that activation with the neutrons did not appreciably affect the purity of the radioisotope produced by the photoreaction. To examine Z-dependence and electron energy dependence on reaction yield, a tenth of the targets Na, Cl (NaCl), Mn, Cu, Y(Y_2O_3), In, Cs($CsNO_3$), Yb(Yb_2O_3), Au, Pb, (each of about 100 mg) were irradiated with bremsstrahlung converted from 20-, 17.5-, and 15-Mev electron beams using the target holder assembly. Amounts of activities produced were determined by a calibrated 3 in. × 3 in. NaI scintillation spectrometer. The (γ,n) reaction yields were calculated on the basis of the decay schemes. As a general trend, the yield increased with atomic number rapidly at low Z number (Z = 15) and gradually at high Z number. The yield ratio for the different energies in heavy elements are 1.0 : 0.6 : 0.21 for 20-, 17.5-, and 15-Mev bombardments. There was good agreement with the known characteristics of the process. It was concluded that the effective irradiation volume was about 1 cm^3 on the front of the converter and irradiation with the 20-Mev beam was adequate for the photoproduction of radioisotopes without any appreciable by-product with neutrons. (P.C.H.)

30161 PHOTOPRODUCTION OF RADIOISOTOPE WITH 20-Mev LINEAR ELECTRON ACCELERATOR. II. PRODUCTION RESULT. Tokihiro Kuroyanagi, Kichizo Tanaka, and Tsutomu Tamura (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 7-9(1963). (In Japanese)

Eighteen radioisotopes were produced by photonuclear reactions with bremsstrahlung. Photoreaction yield and radiochemical purity were quantitatively estimated. The estimation was carried out by the measurements of gamma spectrum and decay rate. In some cases, chemical separation was used to separate (γ,n) and (γ,p) products or to determine the radiochemical impurities in the products. Calcium carbonate was irradiated and production yields of Ca^{47}, K^{42}, and K^{43} were estimated by separating Ca and K by precipitation. By irradiating a Ni target, high purity Co^{57} with a high specific activity was obtained as a composite of the (γ,p) product and the daughter of (γ,n) product. In the photoproduction of Cs^{132}, cesium chloride or cesium nitrate was irradiated. In this case, the other contaminant was successfully lowered by the use of high purity target so that 1.5×10^5 of Cs^{134}/Cs^{132} was obtained and Cs^{134} was the main gamma emitter in the product. Mn^{54} and As^{74} were produced by the irradiation of $KMnO_4$ and As_2O_3. F^{18} and Ti^{45} were prepared by irradiation of LiF and TiO_2. Mn^{54}, Y^{88}, Nb^{92}, and In^{114m} were produced by (γ,n) reaction. Other radioisotopes, Cr^{51}, Rh^{102}, I^{126}, Tm^{168}, Lu^{174}, Re^{184}, and Au^{196}, were also produced by bremsstrahlung irradiation. The isotopes produced were always of high purity; in some cases, there was no need for purification. Specific activity was easily achieved up to 1 mC/g in heavy elements by the (γ,n) reaction. (P.C.H.)

30162 QUANTUM YIELD IN THE PHOTOCHEMICAL DECOMPOSITION OF URANYL NITRATE. Theodor Brings and Restituto Villanueva (Far Eastern Univ., Manila). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 10-11(1963). (In English)

Uranyl nitrate was dissolved in water and the absorption spectrum was determined with an ultraviolet spectrophotometer. The absorption spectrum shows some moderately sharp peaks. The rate of absorption for the samples was determined by Beer's law. After that the sample was irradiated in dark ultraviolet with a flood light equipped with a dark uv filter. The total intensity of the lamp was deter-

mined in spectral intervals by the decomposition of HI, whose quantum yield is known. The absorption of the latter was determined. After trying different catalysts, Pt and Pd in combination with activated charcoal were found satisfactory. After the catalyst had been added, the sample was irradiated for several hours. Consequently some nitrite was formed. The amount of nitrite formed was determined by titration with $KMnO_4$. The end point was not too clear so that the chemical determination had to be supplemented by absorption measurement. The usual precautions were taken. Zero irradiation values were determined and evaporation effects were considered. The final result showed that more than two gram atoms were formed for every Einstein absorbed. (P.C.H.)

30163 PREPARATION OF I-131 BY SOLVENT EXTRACTION. Chin Taik Rhee (Atomic Energy Research Inst., Korea). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 12-14(1963). (In English)

Craig-type discontinuous countercurrent solvent extraction apparatus was used for the separation of I^{131} from irradiated telluric acid. Six stages were considered enough for more than 85% recovery of radiochemically pure I^{131}. The organic solvent phase (TBP–CCl_4) could be used repeatedly as a fixed phase without removal from the cell. A millicurie of I^{131} was prepared per cycle in 0.01% KOH aqueous solution, and the specific activity was mC/~30 μg of KI. Less than 1 hr was necessary for the complete cycle of separation and no shielding or ventilation was necessary for the operation. (P.C.H.)

30164 PRODUCTION OF SHORT LIVED RADIOACTIVE CESIUM. Nagao Shibata, Hiroshi Amano, Tokihiro Kuroyanagi, Eiji Shikata, Kichizo Tanaka, Hiroshi Ebihara, and Tsutomu Tamura (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 15-17(1963). (In Japanese)

Production methods for short-lived Cs radioisotopes were studied by using the reactions: $Cs^{133}(\gamma,n)Cs^{132}$, Xe(p,xn)*Cs; and $Ba^{130}(n,\gamma \rightarrow EC)Cs^{131}$. In the (γ,n) reaction, CsCl and $CsNO_3$ were bombarded with γ rays converted from 20-Mev accelerated electrons. The target was carefully assembled in irradiation to make Cs^{132} a high specific activity. The specific activity of the product in 10 hr irradiation was about 10 mC/g of Cs, and the yield was about 10 mC. The radiochemical purity was more than 99.9%. Xe gas target, of more than 99% purity, was bombarded with 15-Mev protons accelerated by a 160-cm cyclotron. The radioactive Cs nuclides produced Cs^{129}, Cs^{132}, and others were collected on a negatively charged Pt wire and separated very simply from other by products. Cs^{131} activity, which was produced by pile neutron irradiation and separated by the cation exchanger method, was 99% pure with an order of 10 mC. (P.C.H.)

30165 PRODUCTION OF RADIOISOTOPES IN HIGH SPECIFIC ACTIVITY WITH FAST NEUTRONS IN NUCLEAR REACTOR. Nagao Shibata, Hiroshi Amano, Eiji Shikata, Hiroshi Goto, and Haruto Nakamura (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 18-20(1963). (In Japanese)

Fast neutron fluxes and their distributions in reactors were measured. On the basis of the measurements, the production of several radioisotopes was tried with fast neutron reactions (n,p) and (n,α) and the effect of the irradiation on the amount of a radioisotope produced was investigated. The fast neutron flux was measured using several threshold reactions, such as $Al^{27}(n,\alpha)Na^{24}$, $Fe^{56}(n,p)Mn^{56}$, $S^{32}(n,p)P^{32}$, $P^{31}(n,p)Si^{31}$ and $Ni^{58}(n,p)Co^{58}$. The maximum equivalent fission neutron flux of (1.1 to 1.6) × 10^{12} n/cm^2/sec at an output of 40 kw and that of (2.3 to 3.5) × 10^{10} n/cm^2/sec at an output of 10 kw were obtained. Distribution and distortion of neutron spectrum in the reactors from true fission neutron spectrum are discussed, considering the results of flux measurements in the light of reactions that have different effective energy. Many (n,p) and (n,α) reactions were taken into account to prepare radioisotopes in high specific activity. Among them (n,p) reactions on S, Cl, Zn, Mg, and Ni and (n,α) reactions on Cl and Al were investigated to prepare P^{32}, S^{35}, Cu^{64}, Na^{24}, Co^{58}, P^{32}, and Na^{24}, respectively. Yields of radioisotopes by these reactions and their specific activities were proved to be sufficient for practical use. The effect of irradiation positions on the reaction yield was also investigated. The effect was quite clear, especially in the case of a reaction having a larger E_{eff} such as $Cl^{35}(n,\alpha)P^{32}$. The (n,p) reaction has the feature of producing a radioisotope, Cu^{67}, which cannot be produced by the (n,γ) reaction. This is also discussed briefly. (P.C.H.)

30166 PRODUCTION OF RADIOISOTOPES IN HIGH SPECIFIC ACTIVITIES. PREPARATION OF ^{51}Cr IN A HIGH SPECIFIC ACTIVITY BY THE USE OF POTASSIUM CHROMATE. Nagao Shibata, Kenji Yoshihara, Kichizo Tanaka, Haruto Nakamura, and Michimasa Arai (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 21-3(1963). (In Japanese)

Attempts were made to improve the filtration and leaching methods for the preparation of Cr^{51}. The separation of $(Cr^{51})^{3+}$ from target chromate was examined by filtration in an alkaline solution. Various filters were investigated. The most favorable results were obtained by the use of filter paper Toyo, No. 5c, which gave good results in a 0.05 to 0.1N NH_4OH solution. A constant yield of Cr^{51} was observed by exposing the solution of irradiated chromate for 1 hr to 6 days at room temperature. This method is suitable for treatment of relatively small quantities of the target. The separation of Cr^{51} from target chromate by coprecipitation with $La(OH)_3$ followed by leaching with a NaOH + Na_2O_2 solution was also examined. The collection of Cr^{51} in a trivalent state by $La(OH)_3$ was proved to be of high efficiency. The use of 4 to 5% Na_2O_2 gave good results. This method is suitable for treatment of large quantities of target chromate. (P.C.H.)

30167 PRODUCTION OF RADIOISOTOPES IN HIGH SPECIFIC ACTIVITIES. ON THE PREPARATION OF P^{32} IN A HIGH SPECIFIC ACTIVITY BY SZILARD-CHALMERS METHOD. Nagao Shibata, Kenji Yoshihara, Kichizo Tanaka, Hiroshi Baba, and Kiyoyuki Kurosawa (Japan Atomic Energy Research Inst.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 24-6(1963). (In Japanese)

A new method for the preparation of P^{32} in a high specific activity free from P^{33} is presented. The principle of the method lies in using the (n,γ) reaction instead of the (n,p) reaction for preventing P^{33} contamination and following the Szilard-Chalmers method for preparation of a high specific activity product. Potassium dihydrogenphosphate was selected as the target material. By irradiation of the phosphate salt in a reactor, various kinds of condensed phosphates and condensed metaphosphates tagged by P^{32} were formed besides retention as orthophosphate. Condensed phosphates were separated by a strongly basic anion exchange resin, Daiaion SA 100, and recovered in good percentage as the final enrichment factor of $10^3 \sim 10^4$. Condensed phosphate ions were retained in the resin column by passing the 0.1M irradiated phosphate solution and

0.025M KCl and 0.025M HCl mixed solution. The orthophosphate ion was eluted with the same KCl and HCl mixed solution. For elution of condensed phosphates, 8M HCl solution was passed through the column. The percent recovery and the enrichment factor were affected by temperature, time, and neutron flux in neutron irradiation. The former decreased with the increase of neutron flux and more effectively by irradiation time, while the latter was slightly changed. Experiments under rather serious conditions of irradiation, for example, at a neutron flux of 1.1×10^{13} n/cm²/sec for 24 hr, showed that P^{32} in 16 mC/mg of specific activity was obtained with a yield of 1.3 mC/g of KH_2PO_4. (P.C.H.)

30168 THE SZILARD-CHALMERS PROCESS OF COMPLEX-ION ON ION-EXCHANGER. Tatsuo Matsuura (Rikkyo Univ., Yokosuka, Japan). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 27-9(1963). (In Japanese)

Cation-exchange resins of hexamminecobaltic(III) and triethylendiaminecobaltic(III) ion forms were irradiated in the reactor, using ammonium citrate solution (pH 5.0) as eluent for radioactive aquocobaltous ion. The experiments were done both by batch and column methods. In the batch method, it was found that retention depends on the target ion form, time of irradiation, time elapsed after irradiation, and neutron flux. In the ethylendiaminecobaltic system, the retention (60% ~ 90%) was found to be much larger than in the hexamminecobaltic one (15% ~ 80%), in parallel with their stability constants. If the resin is diluted with hydrogen form of the resin, the retention is markedly lowered (2% ~ less than 0.1%), and decreases further with time. The maximum specific activity of the eluant reached 5 μC/mg for the samples irradiated for 5 min (thermal flux is about 1.2×10^{12} n/sec/cm², Cd ratio about 2.5); the corresponding enrichment factor was about 220. The column method was performed in several runs mostly in the central thimble of the reactor (thermal flux about 4×10^{12} n/sec/cm², Cd ratio 2.5). As expected, the retention was found to be considerable below 1% for the hexammine system). However, the specific activity did not exceed a few microcurie per milligram. This means that about one million inactive cobalt ions per one radioactive one are produced in the eluant. It is supposed that gamma radiation or the fast neutron component in the reactor are responsible for this effect. (P.C.H.)

30169 FAST RESPONSE AND PRECISION BETA-RAY THICKNESS GAGE. Shouzou Umeda, Masami Simizu, and Matsuo Sawaguchi (Kobe Kogyo Corp. Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 30-1(1963). (In Japanese)

A beta-ray thickness gage with fast response was constructed for use in the shear line of steel plate industry. A path line change of 30 mm, which occurs by wriggling the plate to be measured when it is sheared off, causes an error less than 1.5% of the indication. The time constant is 0.1 sec, and statistical error is 0.1% for the usual range. (JAIF)

30170 β-RAY THICKNESS REGULATOR IN PLASTIC SHEET PLANT. Kiyoshi Koizumi (Sanbo Resin Industry Co., Ltd.); Tadashi Mori, Hirohide Miwa, Masami Shimizu, and Mutsuo Sawaguchi. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 32-5(1963). (In Japanese)

Equipment for the thickness regulation of plastic sheet, using β-ray thickness gage as thickness detector, is described. The equipment consists of a β-ray thickness gage, integral circuit, voltage-time converter, program unit, failure detector, and calibration unit. The control mode is the sampled-data control because of the large dead time of the process, and the manipulated variable is proportional to the mean of the thickness deviation of the sheet. In practical use the variation of the thickness of the sheet can be suppressed within ±3%. (P.C.H.)

30171 THICKNESS, HEIGHT AND POSITION GAGING FOR SMALL METAL CYLINDERS. Ralph B. Blanco (Philippine Atomic Energy Commission). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 36-9(1963). (In English)

A method for the determination and control of height and thickness of metal cylinders to within ten-thousandths of an inch tolerance was developed with the aid of radioisotopes. A beam of beta particles from a source with a maximum energy range of 0.54 Mev was made to pass through a collimator. The metal cylinders to be gaged were positioned in front of the collimated beam. The setup was arranged in such a manner that the attenuation of the beam was proportional to the height of the cylinders. Thickness gaging was made by means of backscattering of the collimated beta beam. The method was adopted to ensure possibility of thickness gaging on all sides. Some difficulties were encountered since backscatter was very sensitive to the position of cylinders. It was also noted that the accuracy of the gaging was dependent upon the range of thickness of the cylinders to be gaged. Thicknesses should at least be below ½ of half-thickness of the material for reliable and consistent results. Position gaging was made by the transmission method. It was necessary for cardboard disks, which were inserted inside the metal cylinders, to be properly seated at the bottom of the cylinders. Attenuation of the beam was made to depend upon the geometrical position of the cardboard disks. Difficulties encountered were the calibration and proper interpretation of the readings of the attenuated beam. (JAIF)

30172 ANALYSIS OF MANUFACTURING PROCESS OF ASBESTOS CEMENT BOARD BY GAMMA-RAY CONCENTRATION METER AND BETA-RAY THICKNESS-GAUGE. Hiroshi Imamura, Kaoru Uchida, and Hiroshi Tominaga (Ube Industries, Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 40-2(1963). (In Japanese)

For the purpose of getting data for process control, two gamma sources (Cs^{137} 1C and 0.5C) were set outside of two vats of the wet machine and G-M probes were put into both vats, then concentrations of the slurries (about 15% in weight, 1.11 in specific gravity) were observed continuously by detecting transmitted gamma rays. By gaging levels of the slurries in both vats with the usual air-purge method, weight thickness of raw slate (about 0.6 g/cm²) were measured by beta transmission (Sr^{90} 100mC). The distance of gamma transmission in the slurry was set at 40 to 50 cm, in order to keep precision within ± 0.5% in concentration or ±0.004 in specific gravity. In the beta transmission gage, the mass absorption coefficient determined was 8.9 cm²/g in the thickness range 0.6 to 0.7 g/cm²; consequently precision in thickness was about 2 mg/cm². From records of both concentrations, both levels, and slate thickness observed over three days, calculations were made of standard deviations, simple correlation coefficients, partial correlation coefficients between thickness and other variables, and regression coefficients of thickness upon other variables with confidence intervals. It was found that in order to control slate thickness within ±3% (relative), it was necessary to keep the slurry concentration in the range of fluctuation of ±0.6 per cent (absolute) and the levels in the range of ±4 cm. It was concluded that the concentration is a more important quantity than the level of slurry as a control factor in the manufacturing process. (P.C.H.)

30173 METHOD FOR MEASURING DENSITY AND THICKNESS OF OBJECT BY γ-RAY SCATTERING. Iichi Tajiri, Michihiko Shimada, Masashi Mitsutsuka, and Minoru Yamate (Yawata Iron & Steel Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 43-5(1963). (In Japanese)

Experiments concerned with sensitive and exact measurements of the density and thickness of an object, reducing such disadvantages as usually occur in the ordinary scattering method, are reported. The essentials of the experiments are that γ rays emitting from the source are collimated, directed, and scattered into the object undergoing measurement, and thus scattered γ rays are again collimated and directed into the detector arranged on the same side of the source, with a suitable distance selected corresponding to density and thickness of the object undergoing measurement. The results show that a more average density of a material can be measured sensitively and exactly as compared with usual methods. The density of an object contained in a vessel made of steel plate up to about 20 mm thick can be measured from outside the vessel, and the thickness of a steel plate can be measured up to about 40 mm. The thickness of a vessel wall made of steel plate can be measured up to 20 to 35 mm. (P.C.H.)

30174 ON A DENSITY METER OF SURFACE TYPE UTILIZING GAMMA-RAY BACK-SCATTERING. Teiji Uemura and Hiroshi Sasakura (Industrial Research Inst., Osaka Prefecture). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 46-8(1963). (In Japanese)

Measurements were made on the variation in counting rates with width of the gap, d, for several different arrangements. A Co^{60} source of 70 μC and samples of saturated thickness of different densities (0.896 ~ 2.91 g/cm^3) were used. The measurements were carried out efficiently with a NaI scintillation counter at first. On the optimum arrangement, the measurement was carried out with three G-M tubes. When a simple shield of Pb was added to a shield of primary γ rays, the variation in counting rates with d decreased effectively. From the measurement of discriminated pulse at the high energy (about 0.26 Mev), it was found that the contribution on the variation due to smaller angle scattering dominated when the d was small. It is desirable to detect the multiple scattered γ ray in preference to the smaller angle scattering. (P.C.H.)

30175 INVESTIGATION ON THE BEHAVIOR OF RAW MEALS IN A CONVEYING SYSTEM TO A ROTARY KILN, AND THE REGULATION OF THE FLOW RATE. Hiroshi Imamura, Junro Tsujii, Makoto Yokooji, and Hiraki Sonoda (Ube Industries, Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 49-51(1963). (In Japanese)

After investigations on the flow behavior of raw meals in a conveying system with gamma rays from Cs^{137}, the characteristics of a feedback control system were tested using radiation as a detection element. It was found that the charging rate did not seem to be proportional to revolutions of the rotary feeder. In order to find the causes of the disturbance that breaks down the proportional feeding, radiation sources of Cs^{137} were placed on the hopper, overflowing screw conveyor, and inlet chute. Thus, a preliminary automatic control system was constructed, in which the charging rate defined by y (transmitted radiation intensity at the inlet chute) was fed back to revolutions of rotary feeder, where the revolution ratio of kiln to rotary feeder was not maintained constant. The reciprocal of revolutions of rotary kiln was adopted as a set point of the control system. The reciprocal was determined by a digital counting of the time required for a revolution. Reasons for the conversions are discussed. (P.C.H.)

30176 ONE METHOD FOR THE MEASUREMENT OF VOID FRACTIONS AT THE EXPERIMENTAL EQUIPMENT SIMULATING A MARINE BOILING WATER REACTOR. Eikichi Shima, Kugao Nojima, and Teruo Tamai (Ishikawajima-Harima Heavy Industries Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 52-4(1963). (In Japanese)

A method for the measurement of void fractions is presented. The cross section of the test section in which the steam pressurized under 70 kg/cm^2 was generated by electric heaters was similar to one of a representative reactor core channel, which was inclined and rocked simulating a ship's motion. The fluctuation of void fractions was measured in the test section on the principle that the absorption coefficients of gamma rays are different between waters having different densities. The void fractions were measured to 1% accuracy. Thin-walled slits were made at the measuring positions on the vessel in order to make efficient use of the gamma rays. Avoiding the errors by means of drift of counter units, only scattered gamma beams were measured using a single channel pulse height analyzer. As the instrument for the measurement of void fractions at the experimental equipment was inclined and rocked with the test section, the position-setting instrument of the gamma source and detector was designed with due regard to the transverse shake and vibration of the instrument caused by rocking. (P.C.H.)

30177 GAMMA-RAY SOIL CONTENT METER FOR A PUMP DREDGER. Shigeo Kobayashi, Jun-ichi Tarao, and Yuichiro Inoue (Tokyo Shibaura Electric Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 55-7(1963). (In Japanese)

An instrument devised for the measurement of soil content in the dredged mixture of soil and water is based on the well-known principle of a transmission-type gamma-ray density meter. It consists of a Co^{60}-gamma source, scintillation detector, count-rate meter, recorder, and accessories. Installed in a pump dredger, it has proved itself very effective in dredger operation control. Specifications of the instrument are presented. (P.C.H.)

30178 APPLICATION OF GAMMA RAY LEVEL GAGE TO MEASUREMENT OF SOLIDS-LEVEL IN THE BLOWER FURNACE. Hisao Suzuki (Yawata Iron & Steel Co., Ltd.). Tetsuo Sumi, Tadashi Funamizu, and Takashi Sato. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 58-60(1963). (In Japanese)

Since a gamma level gage has no elements that are in contact with the material to be measured attempts were made to apply the gage to a blower furnace. Since the diameter of the furnace and the thickness of the wall are extremely large, hollow tubes were inserted into the wall in order to reduce the absorption of gamma rays. The residual thickness of the wall is equivalent to 60 mm of iron. Hence, 300 mC of Co^{60} was selected as the radiation source, and the scintillation detector as the radiation detector. Actual commercial operation proved the method to be completely satisfactory. (P.C.H.)

30179 GAMMA-RAY LEVEL GAGE FOR THE HIGH PRESSURE VESSEL. Tetuo Sumi, Takasi Sato, and Tatuo Seki (Hitachi Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 61-3(1963). (In Japanese)

A gamma level gage can be used for measurements in a high pressure vessel with thick walls. For such purposes, the detecting system with multiple sources and a scintillation detector is suitable. In order to obtain data for determining the scale of the gage, the relation between intensity of the γ ray and the level was calculated. An experiment in

which 5 sources of 300 mC of Co^{60} were used and the subsequent accuracy of 3% over the measuring range of 400 mm is reported. The result of an equivalent test under 1 atm has showed good agreement with the calculation. The determination of the scale of the gage at the high pressure vessel is based on the results, and the linearity and repeatability of 13% was obtained in continuous measurement. (P.C.H.)

30180 OBSERVATIONS OF GROUND SINKING AT NIIGATA CITY. Shun-ichi Sano and Hiroshi Kanaya (Geological Survey, Japan). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 64-6(1963). (In Japanese)

In order to investigate the ground sinking at Niigata City caused by the shrinkage of stratum due to discharge of the ground water, a method for measuring the distribution of partial shrinkage was developed. A radioactive source containing metallic Co^{60}, which is shot into the stratum by a gun perforator through a bore hole was used as the depth mark of the stratum. The vertical displacement of the source was measured by repeated measurements of the depth by a special radioactivity well logging system and partial shrinkage was obtained by distributing the sources vertically. The observation well and instruments were designed so as to reduce the error of measurement within several millimeters. In order to locate precisely the vertical position of the source, a horizontally directional scintillation detector was designed by attaching a slit made of tungsten alloy and the optimum conditions are discussed for measuring the sharp variation of counting rate. A winch was designed to prevent slips in winding up the cable and to make the cable speed continuously variable. Since the precise measurement of depth amounting to several hundred meters is difficult, the position of the source held in the stratum was measured as a vertical distance from the reference source attaching to the casing pipe. The deformation of the casing pipe was observed by checking the vertical intervals of the reference sources that were distributed by equal intervals, by comparing with the interval of two detectors connected vertically. The two actual observation wells, of which the depths are respectively 650 and 950 m, were constructed and some interesting results were obtained in relation to the experimental injection of water into aquifers. (JAIF)

30181 TRAIN DETECTION UTILIZING ABSORPTION AND SCATTERING PHENOMENA OF RADIATION. Akira Kobayashi and Mutsuo Nakaya (Railway Technical Inst., Japan National Railway). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 67-9(1963). (In Japanese)

A new method of train detection using radiation absorption and scattering was investigated. The radioisotope as a radiation source is located on the railway tracks together with a Radiation Electronic Relay (R.E.R.). First the signaling system of the radiation-interruption type was tested. When a γ ray traverses just above the rail and a R.E.R. with a G-M tube is activated by its incidence, the beam is absorbed by the wheels of a passing train, dropping away the R.E.R. at the same time This system may be applied as an axle counter for the automatic control in yard operations. When bremsstrahlung from Sr^{90} of 0.5 C traverses the tracks, the beam is continuously interrupted by the body of a passing train. The above system installed with scintillation detectors is also promising as a train detector. Next, the intensities of back-scattered radiations by massive portions of cars were measured with a halogen G-M tube of 40 × 400 mm. The values of 4000 ~ 5000 cpm were obtained on an average when Cs^{137} of 10 mC was laid beside a rail on the tracks. This count rate agreed well with approximately calculated values. The scattered radiations gave a R.E.R. accurate trip action even with trunk lines, demonstrating the system to be nothing but a train approach signal. When it is necessary to consider the mischecking of the system owing to noisy background pulses, cosmic ray coincidence pulses from two G-M tubes can be used after preparing the second as the spare. (P.C.H.)

30182 THE PRACTICAL USE OF THE RAILWAY SIGNALING SYSTEM UTILIZING RADIOISOTOPES. Shin-ichi Sakai (Tokyo Kyūko Dentetu Co., Ltd.); Ziro Yokota, Hirohide Miwa, Norihiko Nakayama, Shōzō Umeda, and Tatuo Okano. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 70-2 (1963). (In Japanese)

A new railway signaling system using radioisotopes was investigated. Studies were made on durability against vibration, temperature, and dampness of the new equipment by use of the trains fitted with the radioisotopes. A halogen-quenched G-M counter was installed between rails at each position corresponding to the entrance and the exit of the crossing. Each counter was connected to an electronic circuit involving a relay. When the train fitted with the Co^{60} source passed over the entrance, the counting rate of the G-M counter rapidly increased, activating the relay. When the train passed the exit, the relay was reset. Relay actions of the traditional signaling system and the new signaling system were recorded together by the electronic recorder over three months, and the results were examined in detail. With the testing terms used, the maximum temperature of the G-M counter reached 51°C and that of electronic circuits 43°C. (P.C.H.)

30183 QUICK MEASURING METHOD OF MULTI-QUANTITATIVE SAMPLE. Yasuo Otani, Fumihiko Kamijo, and Tohru Hirayama (Central Research Lab., Showa Denko K.K.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 73-5 (1963). (In Japanese)

A measuring technique that proves more effective than the ordinary G-M probe measuring device and can dispense with time-consuming chemical treatment of the sample was developed. The technique comprises what might be called the infinite thickness and plane method, which involves the use of four end-window-type G-M counters and sample trays. Experiments showed that the new technique is sufficiently effective with respect to a nuclide having relatively high radiation energy, and that the test sample is required only to have an extremely low level of specific activity, so that the technique is advantageous from the standpoint of safety. The technique is applicable not only to tracer analysis of the process, but also to plant analyses in general. Discussion is presented on the determination of counting efficiency of a measuring apparatus and effects on background. (P.C.H.)

30184 A TRACER-TECHNIQUE EMPLOYED IN THE EXPERIMENTS FOR DESIGNING FILTER-UNITS FOR REMOVAL OF RADIOACTIVE CONTAMINANTS IN RAIN-WATER. Shozo Kadoya, Shigeki Ariyoshi, and Masakazu Horioka (Ebara Mfg., Co.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 76-8(1963). (In Japanese)

Attempts were made to estimate the uptake capacity of filtering medium by applying a tracer technique by adding a stable nuclide or nuclides as a carrier of the same element as the radionuclide under investigation. In order to avoid laborious time-consuming laboratory work in ordinary column tests, attempts were made to devise a simplified method for estimating the uptake capacity by merely measuring the specific activity of the total pooled samples

once after establishing the breakthrough curve of that nuclide under the specified conditions. The subsequent calculation based on the measurement was found to yield satisfactory results for practical use. Many preliminary tests were carried out with an inorganic ion exchanger of clay minerals such as vermiculite, heat-treated vermiculite, and zeolite with respect to the removal of Cs^{137}, Sr^{90}, Sr^{89}, and I^{131}, and also similarly with activated carbon or charcoals. For estimating the life of the function of decontaminating the dissolved ionic contaminants of the filtering units in the designing stage, a simulated radioactive rainwater having chemical constituents enriched 180 times and spiked with a radioactive nuclide was used. The experimental model filtering unit, a combination of heat-treated vermiculite and activated carbon or charcoal, was just a portion of the proposed prototype filter unit different only in filtering area. The upper layer of the filtering media was a bed 35 cm deep of heat-treated vermiculite and the lower layer was 10 cm of activated carbon or charcoal. (P.C.H.)

30185 ACTIVATION METHOD APPLIED TO DILUTION MEASUREMENT IN THE RIVER. Masatoshi Kobayashi, Sumiko Nagatsuka, Sho Maeda, Yasuhiro Horiguchi, and Kunihiko Higashi (Tokyo Metropolitan Isotope Center). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 79-81(1963). (In Japanese)

Methods used for measuring the concentration of nonactive tracer elements determined by neutron activation are given. 100 kg NH_4Br was used as the nonactive tracer chemical. Activation analysis was carried out by irradiation of the water fractions (0.1 cc) in a nuclear reactor. In river water fractions collected prior to the tracer experiments, concentrations of the various elements found were: Mn 0.1 ~ 0.5 ppm, Br 0.1 ~ 0.2 ppm, Na 20 ~ 30 ppm, and Cl 20 ~ 30 ppm. Neutron irradiation for 3 minutes produced Br^{80} as well as Mn^{56}, Na^{24}, and Cl^{38}. The decay curves of the total activity showed the interference of radionuclides other than Br^{80}, which made a graphical analysis of the decay curves impossible. The initial activity of Br^{80} was determined at the detection limit of 1.3 ppm. The equation for the determination is given. (P.C.H.)

30186 MOVEMENT OF PIG IRON IN THE BLAST-FURNACE HEARTH. Hisashi Mori, Midori Matsuo, Minoru Yamate, and Keisuke Mori (Yawata Iron & Steel Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 82-4(1963). (In Japanese)

Steel capsules containing Co^{60} wire were introduced with the aid of a steel tube through a sight glass into the oxidizing zone of a tuyere. Pig iron samples were taken during six successive casts at every 3 to 5 min in a cylindrical mold 60 mm in dia and 40 mm high. The radioactivity of the samples was measured using a scintillation counter in the 100-mm thick steel shield. Where there is a sharp or diffuse maximum of the activity of the Fe during tapping, the position of the maximum on the curve depends as a rule on the time and place of introducing the tracer into the furnace; the earlier and the closer the introduction to the Fe notch, the quicker it appears during casting. It was concluded that in the course of the whole period of accumulation of metal, the Fe does not mix in the hearth to any considerable extent. Determination, by the isotope dilution method, of the residual Fe after tapping was not possible. (P.C.H.)

30187 APPLICATION OF DOUBLE TRACER TECHNIQUE IN THE PROCESS ANALYSIS OF CARBON BLACK PLANT. Tohru Hirayama (Central Research Lab., Showa Denko K.K.); Komin Osada, Kazuyoshi Hamada, Saburo Hatta, and Akio Yamanouchi. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 85-7(1963). (In Japanese)

The double tracer technique in which P^{32} and nonradioactive Au were introduced into the system was used for the process analysis of carbon black. After sampling from each step of the process, P^{32} was measured, and the nonradioactive Au was determined by irradiating the sample in a reactor and measuring Au^{198} obtained from the reaction of $Au^{197}(n,\sigma)Au^{198}$ by means of γ spectrometry. The experiment showed that both tracers had the same residence time, which was shorter than expected. Useful data were also obtained from the dispersion pattern of the material flow for controlling future operations including the time required to change from one grade of product to another. As to the environmental contamination, the conditions of such contamination were checked by collecting dust by an electric cottrell. (P.C.H.)

30188 SOME PROBLEMS ON CONTINUOUS MEASUREMENT OF ENGINE PARTS WEAR. Akira Ohno (Industrial Research Inst., Kanagawa Prefecture); Toshiaki Nojiri, Syuzo Maruyama, and Yasuo Nakajima. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 88-90(1963). (In Japanese)

The use of radioactive valve tappets in an engine was investigated as a method of determining wear of engine parts. Some valve tappets were made radioactive by exposure to neutrons. Two weeks after irradiation, the total gamma activity of the valve tappets was about 14 mC and the effective half life was about 48 days. Measurements were made of the decay of gamma activity and the observed decay curve was consistent with that expected from a mixture of Fe^{59} and Cr^{51}. The engine used in the study was a four-cylinder, 1500 cc, water-cooled gasoline type. Wear was determined by using gamma-counting techniques to follow the concentration of the wear debris in the oil pan lubricant. The lubricating oil was circulated through suitable pipe, drawn by means of a pump unit to a counting cell (the volume is about 800 ml and the efficiency of detection is about 5%) and thence back to the oil pan. The wear debris in the oil in the counting cell was detected by a scintillation counter-head, which contains a NaI crystal (50 × 50 mm). The cell and detector were surrounded by a 50-mm Pb shield, so the background count rate with fresh oil in the system was about 30 cps. The pulses from the photomultiplier were fed to a counting and recording unit. Since the amount of wear on the valve tappets was small, the fluctuation of counting data was large. (P.C.H.)

30189 THE MEASUREMENT OF ENGINE WEAR BY A RADIOACTIVE TRACER METHOD. Naoomi Yamaki, Setsuo Kashino, Syōichi Mogi, and Hyōgorō Aoyama (Resources Research Institute). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 91-3(1963). (In Japanese)

Studies were made on desirable techniques and equipment for measuring piston ring wear by a radioactive tracer method, and also the effects of various factors such as nature of lubricating oils and fuels on piston ring wear. The top piston ring (cast iron) of a diesel engine was irradiated for about four weeks at a neutron flux density of about 1.2×10^{12} n/cm^2/sec. This resulted in an Fe^{59} activity of approximately μC/g. Wear rates of the ring were measured continuously by counting the radioactivity of the wear products in the crankcase oil that was circulating around a scintillation detector. The accuracy of the measurement decreased with an increase in the amount of radioactive wear products in the oil. The results show that only a few hours of engine operation are required to obtain an accurate wear rate in the steady state, if the crankcase oil is renewed within 10

to 20 hr operation. Wear of about 0.1 mg can be measured with an accuracy of 90%. Preferable conditions for wear measurement are discussed, and some of results of studies on wear rate are presented. (P.C.H.)

30190 CONTINUOUS MEASUREMENT OF PITTING WEAR BY RADIOACTIVE SPECIMEN. H. Nakamura, N. Ujiiye, K. Matsumoto, A. Watanabe, and R. Yamada (Ishikawajima-Harima Heavy Industries Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 94-6(1963). (In Japanese)

Activated steel specimens were used for continuous wear tests. The time at which the very first pitting took place was determined with a high accuracy, while the subsequent progress of pitting was observed without disrupting the test. A series of tests were conducted with the specific load and the percentage slip as parameters. This was done by collecting all the pitted particles by a 400-mesh metal filter positioned at the center of the well of a scintillator (2 × 2 in.). Turbine oil was used both as the lubricant and the carrier for worn product, the oil being circulated by a gear pump. A pair of specimens of ring form (30 mm OD × 16 mm ID × 8 mm thick), only one of which was activated to a total dose of 5.4×10^{15} nvt and positioned at the retarding side, was placed in the oil bath completely immersed. The amount of wear was measured continuously by referring to the calibration curves prepared using Fe powder irradiated together with the specimen. The precision of detection was of the order of several tenths of a mg. It was found that a pit is formed rather abruptly when a lump detaches itself from the work-hardened surface layer of the specimen and that the pit once formed does not change its size and shape throughout the remainder of the test. (P.C.H.)

30191 PREPARATION OF ION EXCHANGE MEMBRANES FROM GRAFT COPOLYMERS OBTAINED BY VAPOUR PHASE RADIATION GRAFTING. Kenichi Shinohara, Masaya Yanagita, Hiroshi Kawabe, Toshiaki Takamatsu, and Michio Tanaka (Inst. of Physical and Chemical Research). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 97-9(1963). (In Japanese)

The preparation of ion exchange membranes from graft copolymers obtained by radiation grafting of ionogenic monomers to polyethylene powder is reported. Monomers used were methyl acrylate (MA), ethyl acrylate (EA), 4-vinyl pyridine (VP), 2-methyl-5-vinyl pyridine (MVP), styrene (St), and vinyl acetate (VAc). Polyethylene powder of molecular weight 23000 and particle size 100-mesh was irradiated in a monomer vapor by Co^{60} gamma rays of about 60° C or by electrons at 1.6 Mev, washed with a suitable solvent, and dried in vacuo. The dose rate of the gamma rays was 1.9×10^3 r/hr and that of the electron beams was 6×10^4 rads/sec. Degree of the graft was calculated from an increase in the weight of the polymer due to grafting. It was also obtained from O or Ni content of the graft copolymers determined by elementary analysis. Both values showed a good agreement with each other. The degree of graft obtained at a given dose of radiation for different kinds of monomers increased in the order of VAc, MVP, VP, EA, St, and Ma. The efficiency for electron radiation was lower than that for γ rays. Carboxylic-type membranes (CW-1) were prepared by saponification of MA or EA graft copolymer films with alcoholic potash of 1 N-KOH concentration. Sulfonic acid-type membranes were prepared by sulfonation of St graft copolymer films with concentrated sulfuric acid containing 1% Ag_2SO_4. Pyridinium-type membranes (AS-1) were prepared by quaternarization of VP or MVP graft copolymer films with a mixture of methyl iodide and a suitable organic solvent such as nitromethane and acetone prepared in 1 : 1 volume ratio. In all cases, conversion of functional groups of graft copolymers to ion exchange groups could be carried out easily and almost completely, except when the value of the degree of graft was fairly small. In addition to the above membranes, those containing strong acid groups (CS-1) were prepared from VAc graft copolymer films by de-acetylation and succeeding treatment with 30% fuming sulfonic acid. St sulfonic acid type membranes were found to be inferior to CW-1 and As-1 in their properties, especially in their durability. CS-1 had high ion selectivity and durability. (P.C.H.)

30192 RADIATION-INDUCED GRAFT COPOLYMERIZATION OF BUTADIENE TO POLYOLEFIN. Masao Kadonaga, Akira Furuhashi, and Michio Ono (Nippon Telegraph and Telephone Public Corp.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 100-2(1963). (In Japanese)

The gas flow method was used for the radioinduced graft polymerization of butadiene onto a polyolefin. High density polyethylene (PEH), low density polyethylene (PEL), and polypropylene (PP) films were irradiated by Co^{60} in the butadiene gas flow. The grafting ratio is directly proportional to the irradiation time except for the thin films. Optimum temperature for the grafting is found in the range 50 to 60°C in PEH and PP but it decreases below 20°C in PEL. The rate of grafting increases with the increase of film thickness for the same polymer. In the direct radiation grafting of butadiene in the liquid phase, the retarding effect is scarcely observed, and the grafting is homogeneous throughout the film. The rate of grafting in PEH is always higher than that in PEL; therefore, it is not proportional to the amount of amorphous material. The finding that the relations of the rate of grafting onto the same thick films of each polymer are PEH > PP > PEL, and particularly PEH > PEL × PP in the direct grafting in the liquid phase of butadiene, suggests that the grafting reaction is more affected by the degree of branching than the crystallinity of the polymer. It was estimated from the infrared absorption spectra of the graft copolymers that the double bonds of grafted polybutadiene consist of trans-1,4-vinylidene (78%) and vinyl (22%) groups. The cis-1,4-vinylidene group cannot be observed. It was concluded that the mechanism of the grafting reaction is independent of the structure of the polyolefin. (P.C.H.)

30193 THE VAPOR PHASE GRAFTING OF VINYL CHLORIDE TO POLYETHYLENE BY γ-IRRADIATION. III. SOME PROPERTIES OF GRAFT COPOLYMERS. M. Kadonaga, K. Ueda, and T. Kimura (Nippon Telegraph and Telephone Public Corp.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 103-5(1963). (In Japanese)

Graft copolymers were prepared by irradiating polyethylene films (low density) in an atmosphere of vinyl chloride with a Co^{60}-source. Samples of three sorts, grafted films (GP1) (percent graft: 0 to 64%), graft copolymers (GP2) prepared by milling GP1 with mixing rolls at 170°C for 10 min, and polyblends (BP) of polyethylene and polyvinyl chloride blended to give compositions covering the same range as GP1 under the same conditions as GP2, were examined. Tensile strength, elongation and temperature dependency of dynamic elastic modulus, mechanical dissipation factors, and dielectric losses of polyethylene, polyvinyl chloride, GP1, GP2, and BP (film thickness, 0.1 mm) were measured. Thermal flow properties of polyethylene, GP2, and BP were also examined. The data were compared and are discussed. The physical properties of polyethylene were reinforced by grafting, whereas the corresponding

polyblend of polyethylene and polyvinyl chloride had lowered physical properties. The transition temperature of grafted polyvinyl chloride was lower than that of polyvinyl chloride whereas that of polyvinyl chloride in polyblend remained unaffected by blending. (P.C.H.)

30194 GAMMA-RAY INDUCED GRAFT COPOLYMERIZATION OF STYRENE ON CELLULOSE ACETATE. [PART] II. Kiyoshi Hayakawa, Kaoru Kawase, and Tatsuo Matsuda (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 106-8(1963). (In Japanese)

The γ-ray induced graft copolymerization of styrene on cellulose acetate was studied both by immersion and pre-irradiation techniques in the presence of various solvents. The effects of dose rate and monomer concentration on the grafting and the degrees of polymerization ($\bar{P}_n$) of grafted polystyrenes were interpreted in terms of ordinary kinetics, and stress was put on the chain transfer with solvents. In the immersion technique, the styrene–solvent mixture was added to the acetate yarns and the whole mixture was sealed under high vacuum and irradiated with γ-rays of Co^{60} at a given dose rate. In pre-irradiation technique, the acetate yarns were irradiated at 6×10^4 r/hr for 16 hr at room temperature in air and stored at 25°C for a week. After that, the monomer-solvent mixture was added to the irradiated yarns, and the whole mixture was sealed under high vacuum and heated for 3 hr at a given temperature. It was found that the efficiency of grafting by the immersion method decreased with increasing dose. The saturated amount of grafting by the pre-irradiation method was considered to be directly proportional to $\bar{P}_n$ of grafted polystyrene and both were depressed by the presence of solvents. (P.C.H.)

30195 GRAFT COPOLYMERIZATION BY THE TECHNIQUE OF PRE-IRRADIATION IN AIR AT LOW TEMPERATURE. Tatsuo Matsuda, Bunzo Eda, and Keiichi Nunome (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 109-11(1963). (In Japanese)

The graft copolymerization of styrene on polypropylene initiated by the trapped radical formed by gamma irradiation in air at low temperature was studied. The structure of macroradicals formed by irradiation was also investigated by electron spin resonance spectra. It was found that on irradiation in vacuum and in air at –78°C, allyl radical and peroxy radical were formed to a dominant extent, respectively. Radical decay was also followed by esr measurement. On admitting air at –78°C to the irradiated polymer containing allyl radical, the radical changed quantitatively to peroxy radical. The concentration of peroxy radical formed by irradiation in air at –78°C was 1.6 times higher than that formed by irradiation at room temperature. On admitting air at 18°C to the radicals, the former radical decayed with a shorter half life (30 min), and the latter radical decayed with a longer half life (about 13 hr). The polymer was pre-irradiated in air at –78°C and grafted as a function of the time. On storing at –78°C, the degree of grafting did not change. At 15°C, on the other hand, the degree of grafting decreased extremely. As the curve of decrease of degree of grafting was similar to the decay curve of the radical, it was assumed that the grafting was initiated mainly by the trapped radical. The effects of irradiation temperature, grafting temperature, and irradiation dose on the grafting and the formation of polystyrene homopolymer were also investigated. (P.C.H.)

30196 EFFECTS OF MONOMER DIFFUSION ON RADIATION-INDUCED GRAFT COPOLYMERIZATION. Hiroshi Matsuo and Mamoru Kondo (Nippon Telegraph and Telephone Public Corp.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 112-14(1963). (In Japanese)

The interferometric method was applied as a direct visualization of the distribution curve of graft concentration of radioinduced graft copolymers. Polypropylene–styrene (PP-St) and polytetrafluoroethylene–styrene (PTFE–St) graft copolymer films were studied. The studies showed the relation between monomer diffusion and the graft reaction and, therefore, the effects of radiation dose and film thickness on the graft composition. The graft copolymer films were prepared by simultaneous γ irradiation. Since polystyrene has a higher refractive index than PP and PTFE, an interferometer was used to estimate gradients of the refractive index from surface to the center of the specimens by observing the localized interference fringes. The diffusion coefficient of monomer in PP does not depend upon the graft concentration. However, in the case of PTFE, no monomer is able to penetrate into this polymer in the usual way, and therefore the grafting is limited to the surface. The diffusion coefficient of monomer in partially grafted PTFE varies with the graft concentration. Observed distributions of graft concentration of the two polymers show quite different characteristics. The distribution curve for PP–St graft film is a catenary and the grafting effect extends to the interior of film with the decrease in dose rate. For the PTFE–St graft, the film grafting layer is limited near the surface of the film, although the depth varies with dose rate, standing time after irradiation, benzene concentration in monomer, and temperature. Furthermore, apparent retardative effects on grafting were observed in the vicinity of the surface in both cases. Calculated distributions of graft concentration of the two polymers are in accordance with those observed. The retardative effect on grafting can be interpreted by the fact that the grafting rate is variable. The effects of dose rate, film thickness, and monomer concentration are explained. (P.C.H.)

30197 GRAFTING OF ISOPRENE TO PRE-IRRADIATED POLYETHYLENE BY TITANIUM TRICHLORIDE. Ayao Amemiya (Tokyo Univ.) and Ikuo Suzuki. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 115-17(1963). (In Japanese)

It was found that polyethylene irradiated in an atmosphere of air has a tendency towards grafting of isoprene, which is difficult to be polymerized by polymeric peroxide, when an alcohol solution of $TiCl_3$ was added to the system. Commercial low density polyethylene films of 0.03-mm thickness were irradiated at room temperature to a total dose of 1 to 8.4 Mr by Co^{60} gamma rays, and then were contacted with isoprene in the presence of a methanol solution of hydrated $TiCl_3$ under outgassing at the temperature of 35 to 65°C. The rate of grafting increases with increasing concentration of $TiCl_3$ over the range 0.054 mole/l. After contact time of 3 or 4 hr the rate falls off, as 90% grafting in 0.054 mole/l and 30% grafting in 0.0054 mole/l is approached in the case of total dose of 4.27×10^6 r. When total dose and sources for irradiation are varied, there is little difference on the initial rate of grafting over the range of total dose 1 to 8.4 Mr, while the amount of grafting saturated increases with increasing total dose. As the temperature of the isoprene rises, the initial rate and the amount of grafting increases. From Arrhenius plots the total activation energy of 13.7 kcal/mole was obtained. In the case of butanol, the rate of grafting increases much higher but seems to fall off earlier than with methanol. (P.C.H.)

30198 GRAFT POLYMERIZATION OF STYRENE MONOMER AND MIXED MONOMER OF STYRENE AND ACRYLONITRILE ON TO ACRYLONITRILE–BUTADIENE COPOLYMER. Akira Takahashi and Shoichi Kobayashi (Central Research Lab., Showa Denko K.K.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 118-20(1963). (In Japanese)

Graft polymerization of styrene monomer and a mixed monomer of styrene and acrylonitrile onto an acrylonitrile–butadiene copolymer was conducted by both radiation and a chemical catalyst method. In the experiments, the radiation method used a direct process by which gamma radiation was applied to a uniform solution, and the catalyst method adopted a solution polymerization process that involved as much the same conditions as possible of the radiation method. Where styrene monomer alone was used, the radiation method proved better than the catalyst method from the results of both tensile and impact tests. Moreover, the former process produced less gel. However, where a mixed monomer of styrene and acrylonitrile was used, both methods indicated no appreciable difference in the mechanical properties of product. In the last analysis, the radiation grafting method seemed to be more effective than the chemical catalyst method, even where the trunk polymer has a double bond. (P.C.H.)

30199 RADIATION-INDUCED GRAFT COPOLYMERIZATION WITH TERNARY MIXTURES OF COMONOMERS. Ichiro Sakurada, Toshio Okada, Fujiko Kimura, and Shigeyuki Hatakeyama (Japanese Assn. for Radiation Research on Polymers, Osaka). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 121-3(1963). (In Japanese)

Experiments on radioinduced graft copolymerization with ternary mixtures of butadiene–styrene–acrylonitrile onto regular viscose rayon and PVA fibers and powders using methanol or methanol–water as a solvent are described and compared with that of binary mixtures of the comonomers. Under favorable conditions of mutual irradiation, grafting proceeded more smoothly with ternary mixtures than with the binary ones. Most experiments were carried out with regular viscose rayon at a comonomer concentration of 80 and a very high rate and degree of grafting were observed near a comonomer composition of butadiene : styrene : acrylonitrile = 10 : 40 : 50. The behavior of PVA fibers and powders for grafting with ternary mixtures was similar to those of cellulose. Grafting rate curves corresponding to comonomer compositions at which very high degree of grafting was observed reflected apparently the autocatalytic character of the reaction. For comparison with grafting by the mutual irradiation technique, experiments were also carried out by pre-irradiation. Generally the degree of grafting was very low. It seems that radicals formed by mutual irradiation in the graft polymer phase contribute to high grafting. Some properties of the graft copolymers were also measured. (P.C.H.)

30200 GRAFT POLYMERIZATION ON NYLON 6. F. Kobayashi, T. Iwasaki, and K. Tomita (Nippon Rayon Co., Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 124-6(1963). (In Japanese)

Radiation grafting of nylon 6 with vinyl monomers such as vinyl acetate, styrene, methyl acrylate, methyl methacrylate, and acrylamide using the preirradiation method is reported. Some results on polymerization behavior, properties of the graft copolymer, and estimation of the length of grafted branches, were obtained. Preirradiation was performed in air at room temperature using γ rays emitted from a 315C Co^{60} source of 1.04×10^4 rep/hr. The graft polymerization was carried out in a vacuum at 100°C without any solvents. Crystallinity of the graft copolymers was examined. In the case of vinyl acetate grafting it was found that nylon 6 is decrystallized with an increasing degree of grafting. The phenomena may be related to the melting point, Tg, and miscibility of both polymers. The transparency of various grafted films was also examined. Poly(vinyl acetate) was the most transparent, and polystyrene the least. By acid hydrolysis of the graft copolymer with HCl, the trunk of nylon 6 degraded thoroughly into low molecular compounds. The branches remained alone in the case of polystyrene, and measurement of its solution viscosity in toluene gave the molecular weight of grafted branches. As the irradiation dose increases, the length of branches decreases. As the percent grafting increases, the length and the number of branches also increase. By adding some chain transfer agents into the polymerizing system and elevating the temperature, the molecular weight of branches could be lowered over a wide range. (P.C.H.)

30201 STUDIES ON γ-RAY INDUCED GRAFT COPOLYMER OF STYRENE ONTO POLYPROPYLENE. IV. SOME MECHANICAL PROPERTIES. M. Kadonaga, K. Abe, K. Iino, K. Ueda, Y. Kobayashi, M. Kondo, A. Furuhashi, H. Matsuo, and K. Matsuyama (Nippon Telegraph and Telephone Public Corp.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 127-9(1963). (In Japanese)

The mechanical properties of graft copolymers with polyblends of polypropylene (PP) and polystyrene (PSt) having the same composition as the graft copolymers are compared. Tensile strength (T.S.) in kg/cm^2, elongation (El) in %, elastic modulus (E.M.) in 10^4 kg/cm^2, impact strength (I.S.) in $ft\text{-}lb/in^2$ by the Izot method, and Rockwell hardness (R.H.) on scale L were measured by standardized processes. Efflux rate (E.R.) in mm downward travel of plunger per minute was also measured by Koka-type Flow Tester. The results are tabulated. Elongation was found to decrease remarkably by grafting. In E.M. and R.H., samples which had additive values of PP and PS fractions showed the highest values. (P.C.H.)

30202 PHYSICAL PROPERTIES OF POLYPROPYLENE–STYRENE GRAFT COPOLYMER INDUCED BY IRRADIATION. Shozo Iida, Hiroshi Sakami, Toshiaki Adachi, and Sanyo Hori (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 130-2(1963). (In Japanese)

The physical properties of styrene grafted polypropylene, such as viscoelasticity and thermal expansion in the glass transition region, were measured to get information on the structure of amorphous region. On the other hand, x-ray diffraction measurement and microscopic observation were effected to make clear the effects of graft copolymerization on the crystalline region of polypropylene. It was found that the amorphous region of polypropylene decreased by graft copolymerization. The homogeneously mixed structure of polypropylene and polystyrene was induced by graft copolymerization and formed in the amorphous region. Styrene diffused to the amorphous region and imperfect crystals of polypropylene and polymerized; therefore, a homogeneous mixture of polypropylene and polystyrene formed. Styrene penetrated into the gaps of lamellas, and the amorphous region of pure polystyrene was formed by polymerization. (P.C.H.)

30203 ESR STUDIES OF RADIATION GRAFT COPOLYMERIZATION OF POLYETHYLENE AND STYRENE. Naoyuki Tamura (Japan Atomic Energy Research Inst.); Hiro-

yuki Tachibana, Toshiaki Takamatsu, and Kenichi Shinohara. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 133-5(1963). (In Japanese)

Studies on the grafting of styrene onto polyethylene are described. Polyethylene was irradiated with electrons at room temperature then brought into contact with styrene vapor. The degree of grafting was found to increase with the storage time in styrene. The increase was more remarkable in high-density (HD) samples than in low-density (LD) ones. The degree of grafting decreased slowly with the time stored in vacuo after irradiation until the introduction of styrene vapor. The ESR spectrum obtained on the samples irradiated at room temperature is composed of overlapping curves of six and seven lines at first, the former being assigned to the alkyl radical and the latter the allyl-type radical. Both radicals decay by first order reactions. In HD samples the half lives of the radicals are 2.10 hr for alkyl radicals and 1058 hr for allyl radicals. In LD samples they are 1.10 and 478 hr. Comparison of the behavior of the radicals with those of the grafting suggests that the type of the radical contributing to the graft copolymerization is the allyl type. The NMR measurement suggests that the allyl-type radicals observed at room temperature are related to the crystalline region of polyethylene. The decay curves of the radicals suggest three kinds of radicals decaying by first-order reactions. (P.C.H.)

30204 ELECTRON IRRADIATION OF POLYMER-FILLER SYSTEMS. A. Asatsuma, T. Hirai, and O. Nakada (Hitachi Central Research Lab.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 136-8(1963). (In Japanese)

The reinforcement of plastics by cooperative effects of high energy irradiation and filler loading was investigated. High- and low-density polyethylene and plasticized polyvinyl chloride were used as the base polymers in which 11 inorganic fillers including those of silica, titan white, lead monoxide, and graphite were loaded. The filler content varied from zero up to 50%. Sheet specimens prepared by hot press were irradiated by electron beam in air at 1 Mev with doses of 0, 5, 10, 20, 30, and 100 Mrad. Tensile strength, ultimate elongation, volume resistivity, dielectric constant, dielectric loss, and gel fraction were measured for each of the irradiated and unirradiated specimens. In low density polyethylene-filler systems the cooperative effect of irradiation and filler loading was clearly observed. The tensile strength or toughness (= tensile strength × ultimate elongation) of specimens with 10- to 30-Mrad irradiation and 10 to 20% filling exhibits much higher values than those of untreated ones. The effect may be ascribed to irradiation-induced bonding at polymer-filler intersurfaces. In high-density polyethylene-filler systems the cooperative effect of irradiation and filling was not so clear as in low density polyethylene-filler systems. In a plasticized polyvinyl chloride-filler system, the irradiation reduces the strength while the filler loading causes reinforcement. It was concluded that the combination of high-energy irradiation and filler loading is an effective method for bringing about reinforcement in plastics. (P.C.H.)

30205 RADIATION EFFECTS ON POLYOXYMETHYLENE. Kunio Hikichi, Nariatsu Yamaguchi, Shintaro Sugai, and Jiro Furuichi (Hokkaido Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 139-40(1963). (In Japanese)

The effects of γ irradiation on polyoxymethylene solid polymers were investigated by means of density and dynamic mechanical measurements. Irradiations were carried out at room temperature and in air by Co^{60} γ rays. The irradiation dose was varied from 1×10^6 to 1×10^8 r. The results of density measurements suggest that polyoxymethylene can be classified as a degradation type polymer rather than a crosslinking one. A critical dose above which the degradation predominantly occurs was found to be 5×10^7 r. However, below the critical dose, the polymer may be seen to crosslink a little. Young's modulus was found to increase with increasing irradiation dose. Dynamic mechanical loss was affected by γ irradiation, especially in higher temperatures. The higher temperature mechanical loss peak (α-peak) was found to increase with increasing irradiation dose. (JAIF)

30206 EFFECTS OF GAMMA RADIATION ON AQUEOUS SOLUTIONS OF VARIOUS POLYMERS. I. Sakurada and Y. Ikada (Kyoto Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 141-3(1963). (In Japanese)

Radioinduced crosslinking of polyvinyl alcohol, polyvinyl alcohol partially acetalized with glyoxylic acid, and polyacrylic acid in aqueous solutions was investigated in the absence of air. The critical concentration for gel formation was found to shift to lower concentration in all cases as the dimension of the polymer spheres increased. However, when the charge density in polyacrylic acid became fairly high, the critical concentration increased with increasing expansion of polyions, indicating the prevention of crosslinking of polyions by the strong electrostatic repulsion due to ionized groups. Irradiation of aqueous solutions of polyvinyl alcohol below the critical concentration resulted in the formation of intermolecular crosslinking at the initial stage of irradiation, and thereafter the crosslinking occurred preferentially between the polymer segments belonging to the same molecule. The results are all consistent with the hypothesis that the critical concentration is no other than the polymer concentration where polymer spheres just commence to overlap with each other within the solution. The peculiar curve of gelation dose against polymer concentration, which is commonly observed when dilute aqueous solutions of crosslink-type polymers are irradiated in the absence of air, can be explained by the results. (P.C.H.)

30207 HALOGENATION OF POLYETHYLENE BY RADIATION. Akira Takahashi and Hiroshi Osuga (Central Research Lab., Showa Denko K.K.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 144-6(1963). (In Japanese)

The halogenation of polyethylene by dissolving polyethylene in a hydrocarbon halide followed by irradiation of the solution is described. The relation between dose and the rate of chlorination, dependency on the dose rate, the effect of reaction temperature, G value, and activation energy with respect to the chlorination of polyethylene mainly by carbon tetrachloride were determined. The results and similar experiments involving a catalyst instead of radiation show that the use of carbon tetrachloride may be expected to provide a chain reaction. Since, however, analysis was not made of other products than chlorinated polyethylene, a definite conclusion cannot be drawn. Some physical properties of the halogenated polyethylene thus produced are given. (P.C.H.)

30208 EFFECT OF NITROUS OXIDE ON RADIATION-INDUCED REACTION OF HIGH POLYMER. SENSITIZATION FOR CROSSLINKING OF POLYETHYLENE AND PROTECTION FOR MAIN CHAIN SCISSION OF POLYISOBUTYLENE. Yoichi Okada (Sumitomo Bakelite Co., Ltd., Yokohama); Takao Ito, and Ayao Amemiya. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 147-9(1963). (In Japanese)

Polyethylene (film) and polyisobutylene (block) were irradiated with γ rays from Co^{60} source, in a nitrous oxide at-

mosphere. The irradiated polyethylene showed a decided increase in the insoluble portion (gel fraction) against xylene-extraction over one irradiated in vacuo. The irradiated polyisobutylene, on the other hand, gave a higher viscosity in CCl_4 solution than that irradiated in vacuo. The plots of sol fraction ($s + \sqrt{s}$) versus the reciprocal of dose (1/r) become asymptotic to straight lines for both polyethylenes irradiated in N_2O and in vacuo. Xe is somewhat similar to N_2O. Changes in the probability of crosslinking (q_0) and main chain scission (p_0) were calculated by the equation $s + \sqrt{s} = p_0/q_0 + 1/q_0u_1r$ where u_1 is the average degree of polymerization. The probability of crosslinking increases by 44% owing to N_2O and 10% owing to Xe, as compared with vacuum irradiation. The probability of main chain scission, however, is scarcely affected by N_2O or Xe. Thus the increase in gel fraction is mainly due to a sensitizing effect of N_2O for the crosslinking. The plots of reciprocal of molecular weight versus dose are straight lines for both polyisobutylenes irradiated in N_2O and in vacuo. The number of main chain scissions decreases by 37% owing to N_2O as compared with vacuum irradiation. There was no indication of induced crosslinking due to N_2O observed. Therefore, the effect of N_2O is literally a protection against main chain scission in the case of polyisobutylene. The gel fraction of polyethylene, at low N_2O pressure, increases with pressure, but decreases at high pressure. This is due to the radiolysis of N_2O in the gas phase around polymer specimens. The sensitizing effect of N_2O in itself seems to increase with pressure monotonically. The protective effect for polyisobutylene, on the other hand, is also enhanced with pressure. An energy transfer process in which the absorbed radiation energy by the polymer molecule localizes to the N_2O molecule dissolved seems to play an important role in the sensitization process. (P.C.H.)

30209 IRRADIATION EFFECTS ON POLYMER BLEND. Shozo Iida, Hiroshi Sakami, Toshiaki Adachi, and Sanyo Hori (Government Industrial Research Inst., Nagoya). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 150-2(1963). (In Japanese)

The effects of radiation on a mixture of high- and low-density polyethylene were studied by measuring specific heat and temperature characteristics from the view point of homogeneous blending. It was found that the unirradiated polymer blend had two peaks in the specific heat at the melting point of each polymer and the one irradiated at room temperature also had two peaks. However, the one irradiated in the melted state, had only one peak. It was concluded that the unirradiated and irradiated mixtures at room temperature were blended heterogeneously, while the specimen irradiated in the melted state was blended homogeneously. In the melted state each polymer was mixed homogeneously, but at the cooling process high density polyethylene crystallized at first and then low density polyethylene crystallized. Therefore each polymer was separated. By irradiation in the melted state, crosslinking of each polymer occurred and so, in the cooling process, each polymer could not crystallize separately, thus a homogeneous polymer blend was obtained. Irradiation effects on polymer blends that were stretched or rolled several times in the crystalline state were also studied. The specific heat of stretched or rolled polymer blends irradiated at room temperature had only one broad peak. Because the contact area of blocks of each polymer increased by stretching or rolling, the probability of co-crosslinking for each polymer increased extremely, and each polymer did not separate by heating. (P.C.H.)

30210 INDUSTRIAL PRODUCTION OF IRRADIATED POLYETHYLENE. Koichi Hakamada, Shinichi Ota, and Shotaro Tada (Sumitomo Electric Industries Ltd.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 153-5(1963). (In Japanese)

The radiation chemistry of polyethylene was studied, and new products made from irradiated polyethylene were developed. In comparison with conventional products, these have distinct features. (P.C.H.)

30211 IN VIVO COUNTING OF Sr-85 IN STUDIES OF CALCIUM METABOLISM AND BONE LESION. Teruo Nagai (National Inst. of Radiological Sciences, Chiba). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 172-4(1963). (In Japanese)

Clinical diagnostic applications of an area scanner, linear scanner, and whole-body counter for radioisotope studies of Ca metabolism and bone lesions are described. Tracer doses (1 μC/kg body weight for scanning, 0.1 μC/kg body weight for whole-body counting) of Sr^{85} were injected intravenously to 20 selected subjects (5 normal, 2 with tetanus, 1 with Albright's syndrome, 1 with chondrodystrophia, 5 metastatic bone tumor, and 6 primary bone tumor). The whole-body retention of Sr^{85} was measured with a whole-body counter equipped with two large (25- × 20- × 10-cm) plastic scintillators for a period of about 10 days. The results obtained from area and linear scans showed that significant localization of Sr^{85} occurred in the knee and heel joints of subjects under 20 years of age, and in particular, in cases where the lesions were progressing. Six subjects were studied for Sr^{85} whole-body retention. Significant differences in the retention were found in patients with chondrosarcoma and Albright's syndrome. It was concluded that Sr^{85} studies may give important information on the dynamic state of Ca metabolism or bone lesions even before visualization on radiographs. (P.C.H.)

30212 THERAPY OF HYPERTHYROIDISM WITH I-131. THYROID UPTAKE RATE AND EFFECTIVE HALF LIFE IN I-131 THERAPEUTIC DOSE. Hirotake Kakehi, Noboru Arimizu, Yukio Tateno, and Takekuni Kasuga (Chiba Univ. School of Medicine). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 185-7(1963). (In Japanese)

Precise values of therapeutic I^{131} uptake and the effective half life were studied by a new direct measurement, using a common scaler. Uptake measurements were carried out on various phantoms, each containing 3 mC of I^{131} in the thyroid gland and 2 mC uniform extending over the body as body background. The standard source contained 5 mC of I^{131}, so the thyroid uptake of the phantoms was just 60%. A 1 in. × 1 in. NaI crystal, flat field collimator, and medical spectrometer were used in all measurements. The correct values of thyroid uptake were obtained by experimental methods using crystal skin distance 150 cm, 364 ± 30 kev and crystal skin distance 45 cm, integral counting measurement with inserted lead cone in the collimator. The mean value of the 24-hr uptakes of therapeutic doses of 51 hyperthyroid patients treated with I^{131} is 48%, while that of diagnostic doses measured on the day before the I^{131} therapy is 58%. Difference between the uptakes of therapeutic and diagnostic doses is 10 to 15% in mean value and the standard deviation is 15%. The same relation is shown in 3-hr uptakes. (P.C.H.)

30213 INTRATUMORAL INJECTION THERAPY OF RADIOYTTRIUM CHLORIDE COLLOID. Hideo Asakura and T. Miyakawa (Tokyo Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 188-90(1963). (In Japanese)

The organ distribution of intratumorally injected colloidal Y^{90} was studied. Colloidal Y^{90} (300 μC (0.1 cc)) was injected into N-F sarcomas on the backs of ddD-strain male mice, and the distribution of administered Y^{90} in the organs was investigated. Y^{90} was distributed more in the liver, kidney, spleen, and bone marrow than in the lung and colon; the amount distributed in the cerebrum and testis was negligible. The total amount of Y^{90} distributed to the eight organs was only about 5% of the colloidal Y^{90} administered intratumorally. Next, a clinical study was carried out on the excretion of Y^{90} into urine, when colloidal Y^{90} was injected into skin metastasis of breast cancer, lymph node metastasis of lung cancer, and skin cancer. It was found that the amount of Y^{90} excreted into urine during a week after intratumoral injection was 0.05 to 0.5% of the administered dose, and more than 0.05 to 0.5% of it was excreted during the first and second days. When colloidal Y^{90} is administered intratumorally, most of the Y^{90} remains in the tumor, and the rest is removed into the liver, kidney, spleen, and bone marrow. From the results, it is assumed that the radiation side effects to the whole body caused by colloidal Y^{90} administered intratumorally are negligible. It is recommended that colloidal Y^{90} be injected intratumorally at intervals of 1 to 1.5 cm, 100 μC per point. (P.C.H.)

30214 AUTOMATIC AMINO ACID ANALYZER AS A NEW TOOL IN RADIATION RESEARCH. Hiroyuki Hatano (Kyoto Univ.); Shigetake Ganno, and Tsutomu Amma. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 191-3(1963). (In Japanese)

A new automatic amino acid analyzer with three new quantitative micro-pumps, a new three-wavelength photometer, and a programming system was used for amino acid analysis. Twenty amino acids were gamma irradiated both in dry powder forms and in aqueous solution. Survival amino acids were determined automatically by the automatic amino acids analyzer. The radiosensitivity of tyrosine, tryptophan, and cystine was characteristic under the conditions. A specimen of crystalline bacterial proteinase prepared from Bacillus subtilis was also exposed to γ irradiation under the same conditions, and the proteolytic activity and amino acid composition were measured. As a result, it was found that about 50% of the full activity of the enzyme was left on the damaged enzyme protein from which all the tyrosine had disappeared. This suggests that there must be a conformational change of active structure of the enzyme rather than a decomposition of amino acid structure of the protein. Some in vivo experiments on amino acid determinations in urine of rabbits after whole-body irradiation are also reported. Analyses were carried out successfully for the determination of cysteic acid, taurine, urea, aspartic acid, threonine, serine (plus glutamine and/or asparagine), glutamic acid, citrulline, proline, glycine, alanine, valine, cystathionine, methionine, isoleucine, leucine, tyrosine, phenylalanine, α-amino-isobutyric acid, tryptophan (plus creatinine), lysine (plus ornithine), histidine, 1- and 3-methylhistidine, ethanolamine, ammonia, arginine, and nine other uncharacterized components. (P.C.H.)

30215 SYNERGISTIC ACTIONS OF HALOGENOPHENOLS ON RADIATION INACTIVATION OF MICROORGANISMS. A. Matsuyama, M. Namiki, Y. Okazawa, and I. Kaneko (Inst. of Physical and Chemical Research, Tokyo). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 197-9(1963). (In Japanese)

The synergistic effects of halogenophenols on radioinactivation of microorganisms were investigated in E. coli 2-7 and Zygosaccharomyces soya ZS-5. Cell suspensions with phosphate buffer were γ irradiated at 4°C with or without the addition of test reagent. After dilution with phosphate buffer, the surviving fraction was determined by colony counting. In a test of after effects of irradiated reagent solution, the cell suspension was mixed with an equivalent volume of irradiated reagent solution, and after standing for a given time the viable cells were determined by colony counting. The halogenophenols markedly enhanced the lethal effect of radiation at the concentrations known to be ineffective with their own bactericidal activity. The effectiveness of substituted halogen is in the order of I > Br > Cl; the effectiveness of substituted position of halogen is increased in the order of p- > m- > o-; effectiveness also increases with increasing number of halogen atom. The synergistic action of halogenophenols was greatly depressed by the addition of certain organic materials as cysteine and peptone, or by freezing during irradiation. The results suggested that indirect actions of radiation may play an important role in the halogenophenol actions. It is noteworthy that the irradiation of the reagent solution induced a strong bactericidal activity, and the magnitude of the after effects of irradiated reagent solution also appeared to be varied with differences in chemical structures of the halogenophenols. (P.C.H.)

30216 THE PROPERTIES OF THE MILK IRRADIATED WITH IONIZING RADIATIONS. Yaichiro Umemoto and Yasushi Sato (Nagoya Univ.). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 213-15(1963). (In Japanese)

The effects of gamma radiation on the properties of milk were investigated. The raw milk was completely sterilized by γ rays at a dose of 1.5 Mr. The alkaline phosphatase in milk was inactivated exponentially with increased dosage, but the sole inactivation of the enzyme appeared to require radiation dose of more than 10 Mr heating after irradiation inactivated the enzyme to a marked degree. The amounts of the acid produced by lactic acid bacteria did not differ from those grown on the media of heated skim milk. In a milk culture irradiated at 2.0 Mr, however, the acid production became less than that of heated skim milk. Furthermore, the amounts of nonprotein nitrogen determined at appropriate intervals of time during incubation did not vary with the increased dose. The coagulation time of irradiated skim milk by rennet became longer exponentially with an increased dose, and the time was shortened strikingly by the addition of calcium chloride and lactic acid, particularly, by the former. The curd tension of irradiated skim milk also decreased markedly exponentially with the increased dose, but the retention of curd tension was not completed by the addition of calcium chloride and lactic acid. The physicochemical properties of casein, prepared from the irradiated milk, were elucidated. Nitrogen and phosphorus contents of casein did not change compared with those of the nonirradiated. The viscosity of casein solutions (1%) did not increase with any dose of less than 2.0 Mr, but it increased considerably at 4.0 Mr. Electrophoretic analyses showed that the casein irradiated at 2.0 Mr was separated into α- and β-components with greater mobilities. (P.C.H.)

30217 APPLICATION OF RADIOISOTOPE-LABELED BACTERIA IN FOOD SANITATION STUDIES. IV. ON THE BACTERIAL CONTAMINATION AND DECONTAMINATION OF LIVING OYSTER. Tomoko Bito and Akira Takase (Inst. of Public Health). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 216-18(1963). (In Japanese)

Decontamination of the living oyster was studied by Y^{90}- or Y^{91}-labeled coliform bacteria. At low temperature, pre-

cultural temperature affected the contamination of the oyster but the uptake of bacteria by the oyster was distinctly observed below 5°C. In a study on elapsing change of contamination, it was determined that the whole bacterial load of the oyster depended mainly on the gill, but was not negligible on the digestive tract. The contaminating rate of the oyster was successfully measured by automatic recording of the shift of radioactivity in the contaminated cultural water with a dip-type G-M counter ratemeter and chart recorder, because the bacterial concentration of the closed cultural water decrease according to the bacterial uptake of the oyster. On decontamination of the oyster, it was observed that the most effective temperature existed in the region of 15 to 25°C, and at the upper or lower of this region the decontaminating efficiency decreased. As for the exchange rate of the culture water, the decontaminating effect on the oyster was proportional to an increase of the rate to 7.5 times per hour. However, more was of no effect. An increase in the cultured water volume was harmful for the decontamination of the oyster because of the exchanging efficiency of the water. (P.C.H.)

30218 STUDIES ON THE STIMULATION OF PEARL SUBSTANCE SECRETION BY IRRADIATION. Seiji Ando, Yushiro Harada, and Sorokuro Matsubara (Shizuoka Prefectural Fishery Experimental Station). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 219-21(1963). (In Japanese)

Gamma rays in doses of 500 to 8000 r from a 2000-C source of Cs^{137} were given to oysters in different seasons. 100 oysters per lot were used for each trial. One group was irradiated before the insection of nucleus and another one month after the operation. The thickness of the pearl layer was measured in terms of the difference between the diameter and weight of the inserted nuclei and those of the pearl after culture for several months. When the water temperature is relatively high (August–September) a clear increase of the pearl layer was observed at 500 to 2000 r in one series in comparison with the control, but irradiation in late summer gave no good results in another because a number of oysters died. Optimum dosage in October with moderate water temperature for oyster cultures was 750 to 2000 r and 2000 to 3000 r in 2 different series. Good results were observed in both cases. Optimum dosage for acceleration of the formation of the pearl layer in both series was 1500 to 3000 r when the water temperature was low in December at irradiation. (P.C.H.)

30219 STUDY ON THE NEUTRON ACTIVATION ANALYSIS OF INORGANIC MINOR ELEMENTS IN PLANTS AND SOILS. I. THE DETERMINATION OF INDIVIDUAL RARE EARTH ELEMENTS IN RICE PLANTS AND SOILS BY ACTIVATION ANALYSIS AND FOCUSING CHROMATOGRAPHY. Masao Shibuya (National Inst. of Agricultural Sciences, Tokyo) and Toshio Nakai. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 228-30(1963). (In English)

A method in which focusing chromatography was used in combination with neutron activation analysis using a nuclear reactor was proved to be applicable for the quantitative separation and determination of individual rare earth elements in rice plants and soils. La, Sm, and Eu were found in the rice plant and in rice soil, while Tb, Tm, and Yb were found only in trace amounts. (JAIF)

30220 SENSITIZING EFFECTS OF POTASSIUM IODIDE ON THE RADIOSENSITIVITY OF YEASTS. Mitsuru Oka (Tokyo Metropolitan Isotope Center); Kunio Yamazaki, Gisuke Meshitsuka, Akira Matsuyama, and Mitsuo Namiki. Proc. Japan Conf. Radioisotopes, 5th, No. 4, 231-3(1963). (In Japanese)

The sensitizing effects of KI on the lethality of Co^{60} gamma rays were investigated using haploid yeast, Saccharomyces cerevisiae 8256, and diploid yeast, Zigosaccharomyces soya ZS-5. Buffered suspensions (mainly 1×10^7 cells/ml) were irradiated in air and at room temperature in the presence or absence of KI. It was found that the sensitizing effects of KI increase with increasing dose and KI concentration, and with decreasing pH, and also preirradiated KI solutions are toxic to both unirradiated and irradiated cells. The irradiated KI solutions show the lethal effects in the same order of magnitude as the corresponding I_2-KI solutions. It was concluded that the sensitizing effects of KI on the lethality of radiation are mainly due to the toxic effects of I_2 produced. When cells were suspended in solutions containing both cysteine-HCl and KI irradiated, the KI sensitization decreased with increasing concentration of cysteine and in enough concentration of cysteine the protection reached the same level as that of cysteine alone. Using the scavenging reaction of cysteine, the lethal effects of I_2 in various contact periods were examined. The results indicate that the lethal actions of I_2 were complete in a few minutes and irradiated cells are more sensitive to I_2 than unirradiated cells. The sensitizing effects of KI depend on the cell concentration and decrease in higher concentration of cells. (P.C.H.)

30221 STUDY ON THE INFLUENCE OF X-RAY UPON THE HEMATOCYTES OF THE SILKWORM LARVAE BOMBYX MORI, L. Hiroshi Takeda and Kazuyuki Tanaka (Shinshu Univ., Ueda, Japan). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 234-6(1963). (In Japanese)

Studies were made on the effects of x radiation on the number of blood cells in the silkworm larvae on the 2nd day of the 5th instar. The number of blood cells was found to decrease distinctly. However, the decrease in the number of blood cells has no relation with the sexual difference of the larvae. (P.C.H.)

30222 EFFECTS OF GAMMA-IRRADIATION OF TULIP. EFFECTS REVEALED IN X_1 GENERATION. Hisao Matsubara, Shozo Iba, Mitsuru Oka, and Gisuke Meshitsuka (Tokyo Metropolitan Isotope Center). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 237-9(1963). (In Japanese)

The relations between the effects of gamma irradiation revealed in the X_1 generation and dose, dose rate, and time of irradiation were investigated. Tulip bulbs and plants were irradiated by Co^{60} γ rays in various stages from before flower bud differentiation (July) to the appearance of flower-bud (March). Dosages employed were 100 to 5000 r at dose rates 70 to 80, 700 to 800, and 14000 r/hr. In the late stage irradiation, after completion of the flower bud differentiation (during the months of December and January), plant growth was slightly accelerated at doses of 100 to 500 r, but was inhibited at higher doses. Red spots and streaks were also observed on some of the petals, and doses higher than 1000 r reduced petal width. The effects of high dose irradiation appeared more strongly at the higher dose rate. Higher dose irradiation in the earlier stages (July to October) remarkably reduced the germination (emergence) percentage, plant growth, and flowering percentage. The shape, number, and distributions of the red spots and streaks in the petals depended on the degree of petal development at the time of irradiation. Narrow width petals were observed in the case of high dose irradiation in the late stages of petal formation (December and January). This can be explained by the absence of cell division and the abnormal cell expansion after irradiation. The results suggest that irradiation effects in the X_1 generation may be ex-

plained from the processes of morphogenesis of the tulip plant and flower. (P.C.H.)

30223 STUDY ON THE MECHANISM FOR RADIATION-INDUCED BUD MUTATION IN TULIP. S. Obata, M. Nezu, and K. Kida (Toyama Agricultural Experiment Station). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 240-2(1963). (In Japanese)

Different color spots on the petals of tulips were easily induced by gamma irradiation. The spots were made of a single cell or group of cells. A red-colored spot induced in the epidermal cells as well as in differentiated cells and the spot size was influenced by the stage in the life cycle of the bulb. It indicates that the direct course of bud mutation is somatic mutation in the epidermal or initial cells, which were propagated through subsequent cell divisions mixing with normal cells. The relation between color spot and dose (or dose rate) or chromosomal aberrations was studied, and the relation between anthocyanin pigment formation and the process of alteration was examined on bud mutants. It is suggested that the mechanism of spot formation in tulip petals by irradiation may be explained by assuming point-mutations rather than chromosomal changes. (P.C.H.)

30224 EFFECTS OF CHRONIC IRRADIATION ON EINKORN WHEAT. Seiji Matsumura and Tarō Fujii (National Inst. of Genetics, Misima). Proc. Japan Conf. Radioisotopes, 5th, No. 4, 243-5(1963). (In Japanese)

An experiment was carried out with seedlings of einkorn wheat (Triticum monococcum flavescens), planted at the stage of 3 to 4 foliage leaves on Feb. 23rd at several distances from the source and irradiated with varying dose rates and dosages. The plants were irradiated during their growth and harvested on June 21st. Regular irradiation followed the routine of the γ field; that is, it was applied 20 hr per day starting from April 1st, but before that time, irradiation was occasionally given for measurement of dosage or dose rates and checks of the apparatus. Therefore, total irradiation time from planting to harvest amounted to 1843 hours. Total dosages were calculated as 369 r minimum and 4608 r maximum, intensity being 4 to 50 r/20 hr. Survival rate clearly decreased at the highest dosage, while there was no marked difference between the other five irradiated lots and the nonirradiated one. On the other hand, seed fertility was nonlinearly (gradually at higher dosages) decreased with increasing dosage and reached to about one-half of that of the control lot at the highest dosage. For comparison, seedlings of the same kind were irradiated by 0.5 and 1 kr acute γ rays (1 kr/hr) 15 days after sowing. Survival rate and fertility markedly decreased at 1-kr irradiation. The results were not easily comparable with those of chronic irradiation because acute irradiation was done only in the early seedling stage. Acute 1-kr irradiation showed severe effects and a similar effect was seen at the highest dosage of chronic irradiation (4607 r). Thus, the plants must be more tolerant to higher dosage when radiation intensity is low. (P.C.H.)

30225 SOME NEW UPPER LIMITS OF ISOTOPIC ABUNDANCE. F. D. Leipziger (Sperry Rand Research Center, Sudbury, Mass.). 8p. (CONF-74-4)

From ASTM Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963.

Using a spark source mass spectrograph, a search has been made for undiscovered naturally occurring isotopes of low abundance. None was found, although the spark source instrument permitted examination of elements that have not been analyzed in this context for many years. The ability of the instrument to ionize all elements and the ease with which the rarer isotopes may be seen allowed upper limits of <0.000001 at. % to be placed on some isotopes. Beryllium, phosphorus, manganese, cobalt, arsenic, rhodium, gold, and bismuth were confirmed as monoisotopic. (auth)

BIOLOGY AND MEDICINE

General and Miscellaneous

Refer also to abstracts 30011, 30012, 30013, 30014, 30051, 30059, 30070, 30084, 30092, 30098, 30107, 30108, 30112, 30212, and 30213.

30226 (TID-4200) RESEARCH AND DEVELOPMENT IN PROGRESS — BIOLOGY AND MEDICINE, JULY 1963. (Division of Biology and Medicine, AEC and Division of Technical Information Extension, AEC). 360p.

Brief summaries are presented covering the scope of approximately 600 biomedical research projects supported by the Division of Biology and Medicine, AEC. The contracts are with universities, research organizations, foundations, and government agencies. Indexes are included for the principal investigator, contractor, subject, and contract number. (C.H.)

30227 (TID-19053) AN INDIVIDUAL-UNIT SMALL ANIMAL CAGE FOR RADIATION LETHALITY AND LONGEVITY STUDIES. Robert L. Brent (Jefferson Medical Coll., Philadelphia). [nd]. Contract AT10(30-1)-2071. 12p.

Individual small animal cages are described. The cages were designed for use in radiation lethality and longevity studies in mice but could be adapted to other uses. Separate watering and feeding systems for each animal decrease the probability of cross contamination and the cages are easily cleaned. (C.H.)

30228 (TID-19086) STUDIES ON BIOLOGICALLY ACTIVE AMINES. Annual Progress Report, October 1, 1962–June 30, 1963. Yutaka Kobayashi (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). July 10, 1963. Contract AT(30-1)-2085. 12p.

A rapid radiometric method for the assay of histaminase in blood plasma is described. Preliminary results indicate that the method gives accurate results in assay of the plasma titer of this enzyme and may find application as a chemical test of pregnancy. Data are included on histaminase levels in the plasma of pregnant and nonpregnant females. Data indicate that this assay method is at least as efficient as the Aschheim-Zondeck test for pregnancy. Data are included from studies on the purification of histaminase and the effects of x radiation on histidine decarboxylase levels of rat stomach. (C.H.)

30229 (TID-19100) AN EVALUATION OF FOUR CHEMICAL MUTAGENS FOR EFFECTIVENESS IN PRODUCING CHROMOSOMAL ABERRATIONS IN MOUSE LIVER. Final Report. K. G. Stevenson, B. G. Dunavant, and D. P. Epperson (Florida. Univ., Gainesville. College of Medicine). Mar. 1963. Contract AT(40-1)-2892. 50p.

Four radiomimetric substances were tested for the production of chromosomal aberrations in mouse liver. The LD-50 was determined first for each compound. The experimental mice received either a single intraperitoneal injection of this LD-50 or twice weekly injections of 25% of this dose. Controls received injections twice weekly of either saline or saline with Tween 80. The actual full doses and LD values obtained were: ethyl methane sulphonate 0.4 mg/gm (LD-10); Nitromin 0.12 mg/gm (LD-50); Myleran 0.036 mg/gm and chlorambucil 0.028 mg/gm (LD-42); and dimethyl Myleran 0.02 mg/gm (LD-32). Five mice in each LD-50 group, 25% LD-50 group, saline and saline with Tween 80 groups were sacrificed monthly for four months after injections of CCl_4 to induce mitoses in the liver. Counts of chromosomal aberrations in 100 anaphases and telophases were made. When viewed individually, none of the compounds effected a great increase in chromosomal aberrations over those in controls; when viewed together however, all the compounds produced twice the number of aberrations over controls by the end of the first month, but this early decided effect was obscured eventually by the gradual increase in abnormalities with age in normal control mice. Many of the mice which had been injected biweekly for some time with Myleran and chlorambucil or with dimethyl Myleran failed to respond to the regenerative stimulus of CCl_4, an effect indicative of the presence of a heightened mitotic rate in these livers. Control mice showed higher numbers of abnormalities than mice in previous experiments had shown. These results are discussed in terms of the somatic mutation theory of aging. (auth)

30230 (UCRL-10743) BIO-ORGANIC CHEMISTRY QUARTERLY REPORT, DECEMBER 1962 THROUGH FEBRUARY 1963. (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 29, 1963. Contract W-7405-eng-48. 96p.

A versatile solvent was developed to replace phenol for the paper chromatography of radioactive intermediary metabolites in feeding experiments. Results are reported from chromatographic studies of plant lipids using alumina paper; studies of quinone and pigment composition of chloroplasts and quantasomes from Spinacea aleracea; studies on the photochemistry of flavins; studies on quantum-conversion process is photosynthesis, using photoinduced electron spin resonance in solutions of organic electron donors and acceptors as the test system; and a theoretical study of the fluorescence of oriented dye-macromolecule complexes using a planar dye molecule that can be bound with its plane either parallel or perpendicular to the polymer axis. The formation of adenine by electron irradiation of methane, ammonia, and water under simulated primitive earth atmosphere conditions is described. The uptake of numerous organic compounds by Dugesia tigrina was studied. Planarians fed radioactive planarians were shown to retain and presumably incorporate a major fraction of the ingested activity. Results are included from preliminary studies of the molecular basis of memory using planaria as a test organism. (C.H.)

30231 SYNTHESIS AND PROOF OF STRUCTURE OF TRITIATED GLUCOSE AND ITS USE IN THE STUDY OF THE MECHANISM OF UDPGAL-C-4-EPIMERASE. R. D. Bevill, J. H. Nordin, F. Smith, and S. Kirkwood (Univ. of Minnesota, St. Paul). Biochem. Biophys. Res. Commun., 12: 152-6(July 18, 1963).

Results are reported from an investigation of the mechanisms of UDPGal-C-4-epimerase reactions in carbohydrate metabolism using chemically synthesized tritiated α-D-glucose 1-phosphate in which the position of the tritium was established through stepwise degradation of the tritiated glucose. Applications of the degradation scheme for the location of labeled positions in studies of carbohydrate metabolism using hexoses labeled with both C^{14} and/or tritium are discussed. (C.H.)

30232 EARLY DAYS OF ROENTGEN PHOTOGRAPHY IN BRITAIN. Nora H. Schuster. Brit. Med. J., 2: 1164-6 (Nov. 3, 1962).

A historical review of pioneer use of x-ray radiography in Great Britain is given. (H.H.D.)

30233 WIDENING HORIZONS FOR MEDICAL ISOTOPES. Stanley E. Herrick, Jr. (Maine Medical Center, Portland). J. Maine Med. Assoc., 53: 195(Aug. 1962).

The applications of radioisotopes in clinical diagnosis and the attendant hazards are briefly reviewed. (H.H.D.)

30234 INTRODUCTION: PSEUDOMONAS AERUGINOSA INFECTION AND ITS EFFECTS ON BIOLOGICAL AND MEDICAL RESEARCH. Robert J. Flynn (Argonne National Lab., Ill.). Lab. Animal Care, 13: 5p.(Feb. 1963). (TID-17600)

Pseudomonas aeruginosa infection interferes with radiobiological and other studies involving stress. It is also becoming a serious problem to medical clinicians. The promiscuous use of antibiotics is thought to be at least partly responsible for the prevalence of this infection. Other possible causes include the more frequent use of cortisone and ionizing radiations in medical practice, and the development of new disinfectants which are extremely effective against most bacteria but relatively ineffective against P. aeruginosa. This infection is also becoming of increasing importance to those concerned with the care and breeding of laboratory animals. Most, if not all rodent breeding colonies, are infected, but most seriously affected and apparently most susceptible are those colonies derived by cesarean section. (auth)

30235 PSEUDOMONAS AERUGINOSA INFECTION AND ITS CONTROL IN THE RADIOBIOLOGICAL RESEARCH PROGRAM AT OAK RIDGE NATIONAL LABORATORY. John M. Woodward (Univ. of Tennessee, Knoxville). Lab. Animal Care, 13: 20-4(Feb. 1963).

Studies have emphasized the necessity for extreme care in housekeeping procedures as a deterrent in the spread of Pseudomonas aeruginosa. Observance of the usual sanitary precautions in handling of cages, equipment, food, and water must be supplemented by the use of suitable disinfectants to prevent the spread of the organism through the colony. The use of hypochlorite in drinking water and as a disinfectant for various equipment reduced markedly the incidence of P. aeruginosa although complete eradication of this agent was not achieved. It may not be possible to detect the presence of pseudomonads in every instance of fecal or water sampling, and the current bacteriological tests are only indicators of their relative frequency and number. Properly employed and evaluated, these techniques are extremely useful in a control program. (auth)

30236 PSEUDOMONAS AERUGINOSA INFECTION AND RADIOBIOLOGICAL RESEARCH AT ARGONNE NATIONAL LABORATORY: EFFECTS, DIAGNOSIS, EPIZOOTIOLOGY, CONTROL. Robert J. Flynn (Argonne National Lab., Tenn.). Lab. Animal Care, 13: 25-35 (Feb. 1963). (TID-17601)

Pseudomonas aeruginosa infection reduced the survival time of lethally irradiated mice from 13.8 days to 6.0 days. Many radiobiological studies were affected, particularly those concerned with protection against radiation injury. Various diagnostic procedures were studied and evaluated. Tests based on P. aeruginosa's unique ability to produce pyocyanin were found to be the most useful for the mass screening of mouse colonies. The most efficient technique consisted of culturing individual fecal or group water bottle samples in Wensinck's glycerol broth at 37°C for seven days and then testing the culture for the chloroform-soluble pigment. The epizootiology of the infection was also studied. One of 12 animal caretakers and about 25% of the cockroaches infesting the animal quarters were found to be infected, but an extensive survey of various inanimate materials (building, equipment, feeds, bedding) showed that when good sanitation is employed such materials are rarely infected. Control procedures based on the removal of the probable source of infection (animate vectors) and the prevention of the spread of existing infection through good sanitation are described. (auth)

30237 RADIATION SHIELD FOR CHEST FILMS. Erich Goldmeier (Veterans Administration Hospital, Perry Point, Md.). Maryland State Med. J., 10: 663-5(Dec. 1961).

Although many protective devices have been suggested for use with upright chest films, most are cumbersome shields which stand on the floor, either stationary or on wheels to be pushed into place. Their height has to be adjusted for each patient individually. These arrangements are inconvenient, and often ineffective. A suspended shield is described that is lowered and raised by pulleys and counterweights. In addition to the shield for the body at the lower edge of the film, there is a smaller shield for the head. The purpose of this is to enforce proper leveling of the shielding device. The distance between the top and the bottom shield is 14.5 in. allowing coverage of 15 to 16 in. on the film. The technician is instructed not to show the head shield on the film. Therefore, at least one in. will be cut off at the bottom of the film. The device is easy to construct from parts obtainable in a hardware store. The shields themselves can be made from discarded lead rubber aprons. The upper edge of the apron should be level with the upper edge of the wooden support, and the distance between the head shield and body shield should be 14.5 in. or less. The shield should be suspended so that it will rest lightly against even a thin patient. (H.H.D.)

30238 A SUBSTANCE WITH ANTIRADIATION ACTION ISOLATED FROM SPLEEN. B. Neppi and M. Bertoncelli (Laboratorio di Ricerca della Bioindustria, Novi Ligure, Italy). Minerva Med., 51: 4469-71(Dec. 20, 1960).

30239 A SIMPLE METHOD OF ULTRAVIOLET, MICROBEAM IRRADIATION WITH THE USE OF A REFLECTIVE SYSTEM. A. P. Dubrow (Inst. of Biological Physics, Academy of Sciences, Moscow). Radiobiologiya, 3: 317-20(1963). (In Russian)

Light from an ultraviolet (uv) source is passed through a diaphragm and focused with a secondary uv objective on a grating, from which the light is reflected to a mirror-lens objective. A micro-ray of light is formed by the objective, and focused on the object. At the same time, light is fed from below the object in order to observe the object through the same objective and an ocular. The same objective is used to irradiate and to observe the object. The dimensions of the micro-ray can be continuously varied by using an iris diaphragm of the usual type. Both the main objective and the secondary objective can be used to cut down the dimensions of the micro-ray. It is easy to switch from work with a macro-ray (100 micron diameter) to work with a micro-ray (a diameter of 0.3 to 10 microns). A 0.2 micron spot can be attained, and hence, nuclei of yeast cells, virus crystals, and chromosomes can be irradiated individually. (TTT)

30240 RADIOLOGY: AN ABSORBING SUBJECT. PART 1. THE INTERACTION OF X RAYS WITH MATTER.

W. J. Meredith (Christie Hospital, Manchester, Eng.). Radiography, 29: 181-8(June 1963).

Understanding of the process involved in the interactions of radiations with matter is of special significance to those engaged in the use of radiation. Concepts of x-ray interaction with matter are reviewed. Particular attention is given to attenuation of x radiation, scattering, disappearance phenomena, and transmission. (H.M.G.)

30241 CONTROL OF VOLTAGE AND VOLTAGE VARIATION IN X-RAY EQUIPMENT. E. J. Steadman. Radiography, 29: 191-202(June 1963).

Changes of voltages in x-ray equipment may affect exposure factors used to a degree that would spoil the diagnostic quality of film. Methods for dealing with external and internal voltage changes, and also with changes that take place before the exposure and those taking place during the exposure, are discussed. (H.M.G.)

30242 RADIOLOGY: AN ABSORBING SUBJECT. PART 2. ATTENUATION IN PRACTICE. W. J. Meredith (Christie Hospital, Manchester, Eng.). Radiography, 29: 215-23(July 1963).

Practical procedures in radiology are governed by the laws of radiation attenuation and absorption. This paper is designed to lead to a better understanding of the processes by which radiation interacts with matter and of the laws that govern this interaction. Particular attention is given to x-ray crystallography, filtration, and various problems of radiography and radiotherapy. (H.M.G.)

30243 ELECTRON MICROSCOPE AUTORADIOGRAPHY OF BACTERIA LABELED WITH IODINE-125. Nobuko O. Kuhn and Carl G. Harford (Washington Univ., St. Louis). Science, 141: 355-6(July 26, 1963).

The low-energy extranuclear electrons emitted by I^{125} can be used for electron microscope autoradiography with results comparable to those obtained with tritium. Radioautographs of tritium-labeled bacteria showed that 71% of all reacted grains localized on the cell. This figure was 86% when I^{125}-labeled bacteria were used. (auth)

30244 WATER AND CHOLINE METABOLISM IN THE ORGANS OF WHITE RATS EXPOSED TO γ-RADIATION. Ts. K. Putnynya. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 87-116(1962).

This paper is divided into 3 separate parts: I. The water and choline contents in the organs of rats kept on diets of different nutritional value. 15 rats were kept on a full laboratory diet consisting of oats, barley, cabbage, carrots, beetroots, bread, meat, yeast, and milk. Ten rats were kept on a full diet consisting of wheat biscuits to which 25% of a protein-vitamin complex had been added, and a further 10 rats were maintained on a deficient diet consisting of wheat biscuits alone. After 1 month the liver, lungs, kidneys, muscles, and skin were investigated. In animals kept on a full diet, the weight of the liver, and in animals kept on a deficient diet the weight of the kidneys, were significantly higher than in the other groups, but no significant changes in the water content could be observed. The choline contents, as estimated by the method of Acker and Ernst, were higher in the liver, lungs, and kidneys of animals on an adequate diet. II. The choline content in the organs of rats on different diets and exposed to γ radiation. Male rats were divided into 2 groups, one of which was kept on wheat biscuits alone (inadequate diet) and the other on biscuits containing 25% of a protein-vitamin complex (adequate diet). The animals were exposed to a single dose of γ rays (700 r) emitted by the $\Gamma\gamma\tau$ Co-400-1 (GUT Co-400-1). The organs were investigated 36 to 42 hours, 5, 10, 20, and 50 days after the exposure; groups of 4 to 7 rats were investigated simultaneously. It appeared that independent of the diet, the choline content of the liver increased significantly 5 to 10 days after the exposure. The slight increase observed 36 hours after exposure in some rats fed on the adequate diet was statistically insignificant. Beginning at the 20th day, a significant increase could be observed in the choline content of the lungs in rats kept on the full diet. Radiation did not influence the choline content of the kidneys, muscles, or skin. III. The water content of the organs of rats fed on different diets and exposed to γ radiation. Slight changes in the water content of the organs proved to be statistically insignificant. (OTS)

30245 QUANTITATIVE CHANGES IN THE IRON CONTENT OF THE HEMOPOIETIC ORGANS OF RATS IN DIFFERING NUTRITIONAL STATES, EXPOSED TO IONIZING RADIATION. G. D. Solzaemietse. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 159-69(1962).

Thirty adult rats each weighing between 250 and 300 g, and 30 young rats each weighing 60 to 70 g were used in the experiment. Each group was further divided into 3 subgroups. The first of these was kept on the standard laboratory diet; the second was kept for 20 days on a deficient diet consisting entirely of wheat biscuits. The animals of the third subgroup were kept for 20 days on the same deficiency diet as those in the second subgroup, but were then placed for 30 days on a reinforced diet consisting of wheat biscuits enriched with 25% of a protein-vitamin complex. The iron contents of the blood and the organs were next investigated. Accumulation of iron in the hemopoietic organs of the animals kept on a deficiency diet indicated disorders of the iron metabolism, which was most probably due to an impairment of the hemopoietic function. There was a decrease, as yet unexplained, in the iron content of the diaphragm and the myocardium. After addition of the protein-vitamin complex to the diet (3rd subgroup), the iron level in the hemopoietic organs decreased and that of the diaphragm increased again, but only in the adult animals. In young animals, the iron content of the diaphragm continued to decrease. The iron content of the myocardium also continued to decrease in both adults and young, even after addition of the protein-vitamin complex to the diet. In the second series of experiments, 50 rats were kept on a balanced diet consisting of wheat biscuits enriched with a protein-vitamin complex and 50 other rats on a deficient diet consisting of wheat biscuits alone. Each group was divided into 5 subgroups of 10 rats. Five rats in each subgroup were exposed to a single γ dose of 700 r, emitted by the $\Gamma\gamma\tau$ Co-400-1 (GUT Co-400-1) apparatus, and the other 5 rats served as control. The iron levels in the blood and the hemopoietic organs were investigated 36 hours, 5, 10, 20, and 50 days after the exposure. In the first few days after exposure there was an increase in the iron content of the spleen and the bone marrow, more marked in animals on the balanced diet. (OTS)

30246 DEVELOPMENT OF HOMOTRANSPLANTATION ANTIGENS IN MOUSE HEMOPOIETIC TISSUES. Gino Doria (Oak Ridge National Lab., Tenn.). Transplantation, 1: 311-17(July 1963).

Development of homotransplantation antigens was investigated by determining the ability of hemopoietic tissues from C3H fetal, neonatal, or adult mice to induce transplantation immunity in adult LAF_1 mice. Transplantation immunity in LAF_1 mice was estimated by measuring the rejection of a challenge dose of adult C3H bone marrow. C3H antigens were detected in 90-day-old spleen, neonatal

and embryonic (17½- and 15½-day-old) liver. No antigenicity could be found in 13½-day-old liver. (auth)

30247 ONTOGENESIS OF IMMUNOLOGICAL COMPETENCE OF LYMPHOCYTES IN CHICKEN SKIN. J. B. Solomon (Royal Cancer Hospital, London). Transplantation, 1: 327-33(July 1963).

The earliest appearance of immunological competence against transplantation antigens has been shown in 3-day-old chick skin since when it was grafted on the chorioallantoic membrane weak splenomegaly was induced in the embryo. This has been confirmed by the ability of skin from 2-day-old parental strain chicks to reject itself when grafted on genetically tolerant F_1 hybrid adults. The greatest concentration of lymphocytes appears in chick skin at 15 days of age when grafts of such skin can function as effectively as a source of lymphocytes as does the adult spleen. Skin from parental strain newly hatched and day-old chicks contained so few lymphocytes that it was tolerant-responsive and such grafts remained on the genetically tolerant F_1 adults. These results suggest explanations for many curious phenomena in skin transplantation in chickens. (auth)

30248 MOUSE FETAL LIVER AND THYMUS: POTENTIAL SOURCES OF IMMUNOLOGICALLY ACTIVE CELLS. Marvin L. Tyan and Leonard J. Cole (Naval Radiological Defense Lab., San Francisco). Transplantation, 1: 347-50 (July 1963).

Data are presented indicating that 2nd and 3rd trimester mouse fetal liver, 2nd trimester thymus, and perhaps other fetal tissues contain potential immunologically competent cells. The theoretical significance of these data is discussed briefly. (auth)

30249 VACCINATION OF MONKEYS AGAINST GAS GANGRENE CAUSED BY Cl. PERFRINGENS UNDER CONDITIONS OF EXTENDED IRRADIATION. E. K. Dzhikidze and A. S. Aksenova (Inst. of Experimental Pathology and Therapeutics, Sukhumi, USSR). Zh. Mikrobiol., Epidemiol. i Immunobiol., No. 1, 132-7(1963).

Studies were made on the effect of irradiation in small doses, repeated over long periods, on the natural resistance and active immunization of 24 monkeys (Macacus rhesus) infected with gas gangrene. Two- to six-year old animals were irradiated with Co^{60} for 18 to 20 months in daily doses of 1.17 to 1.34 r. The integral dose was 519 to 600 r. Test 1: When the total dose has been applied, a 0.25 to 2 ml intramuscular injection of a Cl. perfringens suspension, activated with 0.1 ml of a 50% $CaCl_2$ solution, was administered. Test 2: Nine monkeys were reimmunized after 9 to 12 months (doses, 270 and 350 r) with a tritoxoid containing perfringens, oedematiens, and tetanus antigens in a ratio of 30 : 40 : 150 serum units per ml; two 1-ml injections were administered subcutaneously at an interval of 1 month, and the same dose was given 6 months later as a revaccination. 21 days after revaccination, i.e., 7 days after irradiation had been terminated, the animals were infected by an intramuscular injection of 3 to 6 times the lethal dose of Cl. perfringens. The antitoxin titers were determined from the antilecithinase activity in vitro before each vaccination and also a fortnight after the second vaccination, 3 weeks after the third, and once a week for the following month. Loss in weight, leucopenia, erythropenia, and reduction of the hemoglobin content were first observed after a dose of 600 r. The rate of survival after infection with 0.25 ml of a Cl. perfringens suspension was equal in irradiated animals and controls, but the former lived somewhat longer before dying. Larger doses of the suspension killed both groups. The antitoxin titers were similar in irradiated monkeys and controls, the first maximum occurring a fortnight after the second vaccination, the next rise (0.25 to 2 AE/ml) after revaccination, and the third maximum two weeks after infection. Up to 25 AE/ml was found in animals irradiated with 600 r, and up to 17 AE/ml after a dose of 519 r and administration of 6 DL. The controls were infected more severely than the animals exposed to 519 r. The seriousness of the disease, therefore, depended on the number of germs introduced and on the antitoxin titer in the blood at the moment of infection. In all monkeys infected with 3 DL, a titer of 0.25 to 1 AE prevented death. Even those animals infected with 6 DL survived. Considerable leucocytosis, increase in the sedimentation rate of blood corpuscles, and loss in weight were observed in this group. Conclusions: Small doses of irradiation over long periods do not reduce resistance to Cl. perfringens, but even seem to stimulate it. Immunogenesis is not affected by integral doses of 500 to 580 r, but a slight negative effect becomes evident with 600 r. (OTS)

30250 EFFECT OF PLUTONIUM ON MINERAL AND PROTEIN METABOLISM IN BONE TISSUE OF RATS. N. I. Elkina and I. A. Tseveleva. p.56-62 of "Plutonii-239; Raspredenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 86 female albino rats weighing 120 to 160 g and on 74 control animals. One group of animals received 20.0 μC/kg b.w. of plutonium (in the form of nitrate or citrate complex, pH = 6.0), and another group received 1.9 μC/kg b.w. Subacute damage developed following the administration of the larger dose, and 20 to 25% of the animals died within a period of 2 months after the administration. This group was examined on the 60th to 70th day. The group of animals which received the smaller dose was examined 1 to 1½ years after the administration of the radioactive substance. The minerals and the nitrogen-containing substances were investigated separately in the spongy and compact bones (epiphysis and metaphysis, and diaphysis, respectively). The bones were washed off the bone marrow with physiological solution and their calcium and phosphorus determined permanganometrically and by the method of Fiske-Subarrow, after mineralization with sulfuric acid, respectively. The metabolic processes in the bones were studied with P^{32}, Ca^{45}, and glycine-1-C^{14}. The simultaneous measuring of Pu^{239} and C^{14} was carried out by the method of R. V. Semov. It was found that the P, Ca, and nitrogen-containing substances were present in the same amounts following both doses of Pu. There was a decrease in the alkaline phosphatase activity in the epi- and diaphysis in cases of chronic injury of 25% after one year, and of 50% after 18 months. The rate of P^{32} and particularly of Ca^{45} incorporation into the epiphysis of the experimental animals was considerably lower than in the controls. The rate of incorporation of glycine-1-C^{14} into the epiphysis in cases of chronic injury was about one half of that in the controls. (OTS)

30251 THE EFFECT IN INCORPORATED PLUTONIUM-239 ON THE BLOOD IN RABBITS. V. K. Lemberg, N. A. Koshurnikova, and K. N. Klyzhuk. p.92-102 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 119 rabbits (Shinshil strain) weighing 2500 to 3000 g. They were administered i.v. 7 and 2 μC/kg b.w. of plutonium nitrate (pH = 2). The peripheral blood and the bone marrow were examined during life and after killing of the animals as well. The investiga-

tion lasted for 15 months. The distribution of Pu in the hemopoietic organs was studied histoautoradiographically. A part of the radioisotope was retained in the reticuloendothelial system. The bone marrow was affected focally due to the distribution characteristics of Pu in RES-cells. The lymphatics were relatively well preserved due to poor distribution of Pu in the lymphopoietic organs (the white pulp of the spleen and the germinative centers of the follicles in lymph nodes). The peripheral blood showed only very slight changes. This was considered as a result of increased hemopoiesis. (OTS)

30252 MORPHOLOGIC CHANGES IN THE LIVER OF RABBITS AND RATS FOLLOWING THE ADMINISTRATION OF PLUTONIUM-239. A. P. Nifatov. p.129-41 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on rabbits and rats. The rabbits received a single dose of 21, 14, 7, and 2 μC/kg b.w. of Pu nitrate (pH = 2.0) i.v. The rats received a single dose of 7 μC/kg b.w. of Pu nitrate i.p. The complex sodium plutonyltriacetate (pH = 6.5) was also injected to rats i.p. in a single dose of 6.3 μC/kg b.w. The rabbits were sacrificed 1, 3, 7, and 14 days and 1, 3, $4\frac{1}{2}$, 6, 9, and 12 months after the injection. The rats were sacrificed 6 and 12 hours; 1, 3, 7, and 14 days and 1, $1\frac{1}{2}$, 2, 3, and 7 months after the injection. The livers of the sacrificed animals as well as of those which died were fixed in 10% formalin and Zenker's formol solutions and embedded in colloidin-paraffin. The sections were stained with hematoxylineosin, with azan for connective tissue, by Pearl's method for the detection of iron and with Sudan-3 (frozen sections) for lipids. The morphologic changes in the liver of the affected animals followed a certain pattern which depended upon the physico-chemical state of the isotope, the dose, and the species of the animals. In the rabbits, liver cirrhosis developed within 3 to 6 months after doses of 21, 14, and 7 μC/kg of Pu nitrate and within 9 months after a dose of 2 μC/kg. In the latter hepatomas and bile duct adenomas were present on the 9th month. In rats, on the other hand, a dose of 7 μC/kg of Pu nitrate produced less marked changes resulting in only slight rearrangement in the liver morphology. The complex salt of Pu caused still less changes in rats than Pu nitrate. (OTS)

30253 APPLICATIONS OF RADIOISOTOPES IN BIOLOGY. C. D. Nelson (Queen's Univ., [Kingston, Ont.]). 6p. (CONF-9-7).

From CNA International Conference on the Operating Experience and Future Development of Power Reactors and on Radioisotopes, Montreal, May 1963.

The history, instrumentation, and techniques of radioisotopes in biology at Queen's Univ. are reviewed. (P.C.H.)

30254 THE INCORPORATION OF RADIOACTIVITY FROM GLYCINE-C^{14} BY MAMMALIAN SPERMATOZOA. C. N. Graves (Univ. of Illinois, Urbana). 6p. (CONF-33-1)

From American Dairy Science Assn. Meeting, College Park, Md., June 1962.

The metabolic pathways of glycine incorporation were investigated by biochemical and radioautographic methods. Results show that glycine is utilized by bovine spermatoza and is incorporated into all fractions of the sperm cell. Incorporation into the nucleic acid fraction and especially into thymine indicates that there is a turnover in the desoxyribonucleic acid during storage of bovine spermatoza. (C.H.)

30255 RADIOACTIVITY IN OCEANIC ORGANISMS. Charles Lamar Osterberg. Thesis, Corvallis, Ore., Oregon State Univ., 1963. 134p.

Zinc-65 and chromium-51 (principally from the nuclear reactors at Hanford, Washington) and zirconium-95—niobium-95, ruthenium-103, and cerium-141 (principally from Russian fallout) were measured in marine organisms and particulate material taken off the Oregon coast. Gamma-ray spectrometry, carried out at Hanford Atomic Laboratories, was used in the analysis of almost one hundred samples of organisms obtained from midwater trawl tows made at transects off Astoria, Newport, and Coos Bay, Oregon, between June 1961 and April 1962. Euphausia pacifica was found to make up the largest portion of the biomass, showing up in sufficient quantity for radioanalysis throughout the year. Zinc-65, formed by neutron activation in nuclear reactors cooled by Columbia River water, provides a tracer of the river water at sea. Euphausiids near the mouth of the river contained up to 150 picocuries of zinc-65 per gram of dry weight, while even those taken 165 miles off Coos Bay (about 250 miles from the mouth of the river) contained about 10 picocuries/g depending on season. Euphausiids taken off southern California and from Alaska had about an order of magnitude less zinc-65 (than Coos Bay), indicating the Columbia River to be a major source of this isotope, although a lesser amount of zinc-65 does appear to be due to fallout. The Russian nuclear weapons tests of 1961 introduced a relatively heavy amount of fission products into the northeast Pacific Ocean. These were quickly taken up by the plankton so that the spectra of euphausiids, salps, and sergestids at times showed strong peaks due to zirconium-95 and niobium-95, ruthenium-103-106, and cerium-141. The maximum activity measured was 618 picocuries of $Zr^{95}-Nb^{95}$ per gram of dry weight of euphausiids taken 45 miles off Astoria in November 1961. Many figures show the seasonal distribution of these fission products in euphausiids, indicating a "hotspot" of fallout off Astoria in November 1961 which gradually dissipated by the following spring. The figures show no apparent correlation between fallout radioactivity and zinc-65, probably indicating independent sources of the two. Radioactivity at three trophic levels was examined using membrane filters to sample phytoplankton (first trophic level) and detritus. Euphausiids represent a second trophic level, while lantern fish (whose stomachs contained principally euphausiids) represent a third trophic level. Zinc-65 was found in the higher trophic levels, but appeared on filters only near the mouth of the Columbia River. The fission products ($Zr^{95}-Nb^{95}$, $Ru^{103-106}$, and Ce^{141}) appeared both on the filters and in euphausiids, but were greatly discriminated against at the third trophic level. Chromium-51, formed at Hanford by neutron activation, was the most prominent gamma emitter on filter samples taken near the mouth of the river, but was nearly absent at higher trophic levels. Euphausiids are considered to be important agents in the vertical transfer of radionuclides in the ocean because they: (1) concentrate radioactivity, (2) make up the largest biomass in the macroplankton, (3) are forage for many predators; and (4) make extensive vertical migrations across the thermocline, feeding at the surface at night, and moving into the depths in the daytime. (Dissertation Abstr., XXIII, No. 12(I))

Biochemistry, Nutrition, and Toxicology

Refer also to abstracts 30005, 30007, 30008, 30009, 30010, 30016, 30017, 30018, 30019, 30022, 30023,

30024, 30031, 30050, 30052, 30056, 30057, 30079, 30150, and 30211.

30256 RADIOMETRIC IDENTIFICATION OF FISSION PRODUCT FRACTIONS NOT SORBED BY HUMIC ACIDS. Mária Szilágyi (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 16: 21-7(1963). (In English)

Although humic acids bind the greater part of U fission products, it was found that there exist some fission products that are not fixed on humic preparations. Further fission products that are not sorbed in the testing conditions (Ru-103, Te-127^m, Se-79, Sb-125) were identified. Their identification was carried out by means of radiometric methods. (auth)

30257 ELECTRON SPIN RESONANCE IN BACTERIOPHAGES. Gerhart Hɔtz, Adolf Mueller, and Karl Guenter Zimmer. Akad. Wiss. Lit. (Mainz), Abhand. Math.-Nat. Kl., 1962, No. 14, 1025-38(1962). (KFK-145). (In German)

In measurements of the electron spin resonance (ESR) of bacteriophages of E. coli B an ESR absorption spectrum in a form not previously found in biological objects was observed. The effects of magnetic field strength were investigated. Results are presented in graphical form. The integrated absorption of the phages showed considerable fluctuation. (M.C.G.)

30258 MULTIPLE LABELING TO DETERMINE METABOLIC PATHWAYS: USE OF LABELING RATIOS. J. T. Van Bruggen and Paul Russell (Univ. of Oregon, Portland). Atomlight, No. 29, 1-7(June 1963).

Studies were made of ethanol metabolism using C^{14}-labeled ethanol and acetate. Male rats were given intraperitoneal injections of the labeled compounds. Saponifiable fractions of liver and carcass tissue were tested for ethanol/acetate ratio. Results indicate that, though some of the administered acetate or ethanol is found in fatty acids and cholesterol, the major part of the acetate carbon is converted to $C^{14}O_2$ in a reasonably short time. The data from the CO_2 studies seem to indicate that with regard to the formation of CO_2, ethanol might well go by a pathway other than that of conversion to acetate. Although the study did not reveal a new pathway of ethanol metabolism, the use of a tracer technique was extended by labeling ratios resulting from multiple labeling. (H.M.G.)

30259 ANALYTICAL STUDIES USING LOW LEVELS OF C^{14} AND TRITIUM: A METHOD FOR DETERMINING THE LABELING PATTERN IN MYO-INOSITOL. Frank A. Loewus (Western Regional Research Lab., Albany, Calif.). Atomlight, No. 29, 8-12(June 1963).

Full use of a specific label is achieved when procedures are also available that permit specific degradation of products and ultimate recovery of isotope in a degradation product that pinpoints the exact location of the tagged atom. In this report, a biological procedure is described that converts myo-inositol to D-galacturonic acid without disturbing the isotopic labeling pattern contained in the cyclitol. Subsequent chemical degradation of D-galacturonic acid by established methods provides a means of ascertaining the exact distribution of isotope in myo-inositol derived from tagged biological sources. (auth)

30260 EFFECTS OF DIETARY IODINE ON THE UTILIZATION OF RADIOACTIVE IODINE BY THE RAT. G. A. Robinson (Univ. of Western Ontario, London, Can.). Can. J. Biochem. Physiol., 41: 1547-55(July 1963).

Sprague-Dawley rats were fed on diets ranging from 40 μg I/kg to 3885 μg I/kg. Single doses of iodide-131 were injected intraperitoneally into each of the rats. In vivo measurements of radioisotope levels were made at intervals for 11 to 15 days over the neck and thorax. Thyroidal I^{131} curves were obtained by using a fraction of the thoracic counts to correct for the extrathyroidal component of the neck counts. Animals on low-iodine diets concentrated I^{131} in their thyroids more rapidly and to greater peak values, had lower protein-bound iodine (I^{127}) concentrations, and lower total thyroidal iodide (I^{127}) content than did rats in the high-iodine groups. An attempt was made to compensate the thyroidal counts for the continuing decrease in the concentration of iodide-131 in the plasma. From this attempt was derived the "thyroidal index," a parameter which may be related to the rate of exchange of the total thyroidal iodine stores. Biological half-life values (I^{131} in thyroid gland) for the low-iodine groups were larger than those for the high-iodine animals. The hypothesis is advanced that, at least for the conditions reported here, the biological half life does not adequately reflect thyroidal activity; exchange of iodine between the rat and its environment is considered to be the more important factor in controlling the numerical value of this parameter. (auth)

30261 BERYLLIUM BINDING BY BOVINE SERUM ALBUMIN AT ACID pH. Sidney Belman (New York Univ., New York). J. Am. Chem. Soc., 85: 2154-9(July 20, 1963).

The binding of beryllium by bovine serum albumin was investigated, at three temperatures, in the pH region 5 and below, where beryllium salts are soluble and dialyzable. Reversible association was studied by the method of equilibrium dialysis in solutions containing nitrate ion at an ionic strength of 0.15. The amount of binding increased with increasing pH and temperature. The constancy of the intrinsic association constant (K = 36.2) and the variation of n, the number of binding sites, suggest that environmental conditions modify the structure of the protein so that a varying number of a single class of binding sites become available for reaction. Considerations of the effect of pH and temperature on beryllium ion hydrolysis and albumin structure support this interpretation. Esterified serum albumin exhibited no beryllium binding, which is evidence for the carboxyls as the reacting groups. The results of potentiometric titrations agreed with those obtained from equilibrium dialysis. Albumin denatured by dodecyl sulfate showed greatly increased beryllium binding, which was attributed to the electrostatic effect of the bound anion. The coöperative behavior of the beryllium binding was ascribed to the structural effects induced by dodecyl sulfate bound to albumin. Although the beryllium species in equilibrium with the protein is unknown, the data suggest that Be^{2+} is one reacting species. (auth)

30262 STRONTIUM AND ITS RELATION TO CALCIUM METABOLISM. F. Bronner, J.-P. Aubert, L. J. Richelle, P. D. Saville, J. A. Nicholas, and J. R. Cobb (Cornell Univ., New York). J. Clin. Invest., 42: 1095-1104(July 1963).

Strontium and Ca metabolism were compared in man without, at the same time, assuming any metabolic relationship between these elements. A set of parameters was developed that have the same formal significance for each element. Present knowledge of Sr metabolism is as yet inadequate to permit affirming whether or not this element behaves in the body as if there were a central pool of constant size. Calcium, on the other hand, is known to have such a central pool. To avoid making any assumption concerning such a pool, each of the body processes (over-all loss, urinary excretion, fecal excretion, and bone uptake) was expressed in terms of its characteristic rate constant. This constant is independent of the real scheme of Sr me-

tabolism. It has the drawback of being much less explicit for a given process than would be a true rate, expressed in units of mass per unit time. It is the only one, however that allows describing Sr metabolism and comparing it with Ca metabolism. Results are presented from a comparison of the Sr and Ca rate constants of the various processes in 15 studies done on 8 patients whose Ca metabolism differed widely. The findings are interpreted to mean that, qualitatively, both Sr and Ca follow the same metabolic pathways, and quantitatively, the use of Sr as a tracer for Ca in a given individual leads only to an approximation of the true value, the degree of error varying unpredictably for a particular case. Whereas all of the parameters of Ca metabolism can be evaluated in terms of unit mass and unit mass per unit time by the combined use of the Ca balance and Ca^{47}, the use of Sr in studies of Ca metabolism can yield information only in terms of an apparent circulating volume and of rate constants. Strontium may be used as a tracer for Ca to measure the mean bone formation rate in groups of individuals whose Ca metabolism is disparate. (auth)

30263 THE EXCRETION OF RADIOACTIVE PHOSPHORUS IN THE PANCREATIC JUICE, AFTER VARYING DEGREES OF STIMULATION BY INGESTION OF CARBOHYDRATES. I. V. Shostakovskaya. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 35-42(1962).

Earlier investigations had shown that various glands of the alimentary tract excrete P^{32} according to a characteristic pattern. Fifteen to 20 secs after intravenous injection, P^{32} appears almost simultaneously in the salivary glands, the gastric juice, and the pancreatic juice. It is present, however, much longer in the secretion of the parotid gland than in that of the submaxillary gland. P^{32} can still be found in the bile a long time after it has disappeared from the blood. Earlier findings concerning the pancreatic juice, however, were based on acute experiments only, i.e., the pattern of secretion could not be correlated to the differing functional states of the pancreas. Two dogs were used, each with chronic pancreatic fistulae. Five minutes before the actual experiment, a solution of P^{32} was administered by subcutaneous injection, in doses of 5, 10, 15, and 25 μC per kg weight, respectively. In the control experiment the dogs received a single 200 g portion of white bread, and in the actual experiments the pancreas was brought into a state of functional stress, by feeding the dogs with 60 g white bread at hourly intervals for 10 hours on 3 consecutive days, giving an additional portion of 200 g on the morning after the experiment. The pancreatic juice was desiccated and its radioactivity, and that of blood, was estimated. P^{32} appeared in the pancreatic juice within 5 minutes after subcutaneous injection. In the control series the activity increased for 3 to 4 hrs, and remained at the maximum level reached. In case of larger doses of P^{32} (10 μC per kg and over), the level continued to increase in an irregular manner. In this group, the activity was higher on the morning after the experiment than on the evening of the experimental day, a fact which shows that physiological rest increases the secretory capacity of the gland. In the actual experiments the exhaustion of the gland led to a gradual decrease in the radioactivity of the juice. In the case of very large doses (25 μC per kg) the pancreatic juice had, 75 hours after the beginning of the experiment, a higher activity than the blood, indicating that the gland is capable of removing P^{32} from the blood and of storing it. (OTS)

30264 THE ELIMINATION OF RADIOACTIVE CERIUM FROM THE BODY WITH THE USE OF TRIETHYLENETETRAMINEHEXACETIC ACID (TTHA), AND TETRAETHYLENEPENTAMINEHEPTACETIC ACID (TPHA). O. L. Torchinskaya, N. O. Razumovskii, V. G. Yashunskii, V. S. Balabukha, and V. F. Ushakova. Radiobiologiya, 3: 270-5(1963). (In Russian)

The compound diethylenetriaminepentacetic acid (DTPA) had been shown to be more effective than EDTA in removing rare earths and heavy elements from the body. The derivatives triethylenetetraminehexacetic acid (TTHA) and tetraethylenepentaminehaptacetic acid (TPHA) were synthesized and compared with DTPA for effectiveness. When injected intraperitoneally as a Ce^{144} complex (dosage 0.1 μc of Ce^{144}/g and 100 μ-mols of complexing agent per injection) in white rats, it was found that the DTPA and TTHA complexes were the most stable in the body. After injection of the Ce^{144} complex, it was found that 2.9% of the activity remains in the bones with DTPA, 4.65% with TTHA, and 77.9% with TPHA, as compared to the activity content in the controls. The kidneys showed activity of 30% of the control for all three complexes. If the complexing agent is introduced within 30 minutes before introduction of Ce^{144} into the body, DTPA and TTHA are both effective in eliminating Ce^{144} from the body, but the effect is considerably less, if the complexing agent is introduced 6 hours before introduction of the activity. If the complexing agent is injected as a series of 12 weekly injections two weeks after introducing the activity, the residual activity in the liver is 4.3% with DTPA, and 6.1% with TTHA, as compared to the controls. TTHA and DTPA are more effective than TPHA. (TTT)

30265 PREPARATION BY ELUTION FROM SPECIFIC AGGREGATES OF THE ISOANTIBODY CAUSING REJECTION OF TRANSFERRED RABBIT LYMPH NODE CELLS. T. N. Harris, Clifton A. Obgurn, Susanna Harris, and Miriam B. Farber (Univ. of Pennsylvania, Philadelphia). Transplantation, 1: 261-9(July 1963).

A fraction of rabbit lymph node cells and splenic cells has been prepared by differential centrifugation of sonically disrupted cells: a high-speed centrifugal sediment from the supernate of a lower speed centrifugation. This cell fraction gives complement fixation with rabbit anti-rabbit-leukocyte serum and gives evidence of containing nearly all the complement-fixing isoantigen of such cells. The antibody in these sera which causes the rejection or suppression of homotransferred lymph node cells can be removed from such sera by absorption with the cell fraction. From the specific aggregates thus obtained the suppressive antibody can be eluted with recovery of 25% of the antibody present in the original serum. The suppressive antibody can be absorbed from such eluates by the cell-fraction. The antibody thus eluted shows properties of a pseudoglobulin. (auth)

30266 COMPARISON OF THE RESORPTION OF RADIOACTIVE Br^{82} AND Na^{24} IN RABBIT MUSCLES. U. Lang. Thesis, Dresden, Medizinische Akademie, 1962. 34p. $2.00.

The resorption of Br^{82} and Na^{24} in rabbit muscles is studied. 2.5 μC were given by intramuscular injection in each case. The results indicate that resorption is nearly the same for both isotopes. The inhibition of resorption by Jenacaine was investigated. (Gmelin Inst.)

30267 FUNDAMENTAL CONSIDERATIONS, METHODS, AND ERRORS OF DIAGNOSIS OF THE THYROID WITH RADIOIODINE. P. Doering. Thesis, Göttingen, Ger., Universität, 1958. 263p. $2.00.

Methods for diagnosis of the thyroid with I^{131} and I^{132} are reviewed. The influence of natural iodine metabolism on the results of thyroid function analysis with radioactive

iodine is studied. The errors of this method can be due to absorption of radiation in tissue, backscattering, or extra-thyroidal deposits. Measurements of iodine activity should preferably use the 364-kev peak of the I^{131} spectrum. The efficiency of ion exchangers for the determination of protein-bound iodine activity is investigated. The diagnostic values of various methods for the analysis of thyroid function are discussed. (Gmelin Inst.)

30268 THE POTASSIUM, SODIUM AND CESIUM CONTENT OF ANIMALS AND THE RELATIONSHIP TO COMPOSITION. Alan Henry Kirton. Thesis, East Lansing, Mich., Michigan State Univ., 1962. 109p.

The potassium, sodium and cesium content of animals and their parts were determined and related to their composition. Live lambs and pigs were studied as well as 38 lb samples of ground pork and lamb. The samples of ground pork and lamb were chosen to cover a wide range in chemical composition. The samples were uniform in size in order to make calibration of the scintillation counting system easier. Potassium-40 and cesium-137 were investigated as non-destructive methods for measuring animal composition. Flame photometry was used for measuring the sodium content and as an alternative method for measuring potassium content. A comparison was made of four methods of extracting potassium and sodium from muscle samples for flame photometry. Extraction by homogenization in a 2% TCA solution was found to be reliable and readily adaptable to the equipment available, so it was adopted for use in this study. Potassium-40 analyses showed that live lambs weighing an average of 88 lb contained 0.18% potassium. Their carcasses averaged 46 lb and contained 0.23% potassium. An average of 37 gm of potassium was removed from the skin and wool by washing the lambs, although they had been shorn rather recently. Flame photometry and potassium-40 measurements were in essential agreement as to the potassium content of the fatty tissues and muscular tissues from lamb carcasses. Similar results were obtained for the ground pork and lamb. For lambs, bone contained approximately one half and fatty tissue approximately one quarter as much potassium as the muscle tissue (0.30%). Pigs averaging 198 lb in live weight had 0.20% potassium in their empty bodies (G.I. contents excluded) and 0.21% potassium in their carcasses. The potassium content of the remaining body compartments was determined individually and the data are presented. Where data were available for comparison, it was shown the composition of the animals, their carcasses and ground meat samples could be more accurately predicted from flame photometrically determined potassium than from potassium-40. The relationships between composition and potassium content were closer for pork than for lamb. In general, the standard errors of the regression equations for predicting composition from potassium content were too large to suggest that the method based on potassium-40 is likely to have any widespread application. Possible reasons for the magnitude of the standard errors have been fully discussed, as well as some possible nondestructive alternative methods for determining composition. The sodium content of various tissues was also determined by flame photometry. In contrast to potassium, the levels of sodium in the carcass of the pig were higher than in the non-carcass compartments. Sodium was found to be less closely related to composition than potassium. The cesium-137 levels in the lambs were found to agree with other data from North American sources. These levels were lower than some published from Scandinavia following nuclear weapons tests. The cesium content of the lambs was found to be unrelated to their composition. (Dissertation Abstr., XXIII, No. 12(I))

30269 DISTRIBUTION OF PLUTONIUM IN RABBITS. Yu. A. Belyaev, V. V. Konstantinova, and N. I. Elkina. p.7-11 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Present experiments were carried out on rabbits, male and female, weighing 2.5 to 3.0 kg. Plutonium nitrate (pH = 2) was injected i.v. at doses of 2 to 7 μC/kg, and the animals were sacrificed 1, 7, and 14 days, and 1, 3, 4, 5, 6, 9, and 12 months after injection. Yu. A. Belyayev's method was used in order to determine the amount of plutonium in the bones, liver, kidneys, spleen, lungs, muscles, bone marrow, and gastro-intestinal tract. The excretion from the liver where it was concentrated up to 70% occurred very slowly – 43% of the plutonium was still present after 6 months, and 21.7% after one year. The initial concentration in the bones was 20 to 30%, but reached a value of 43% after 6 months. The plutonium concentrated in the spongy more than in compact bones, and settled in the marrow when administered in the form of $Pu(NO_3)_4$. (OTS)

30270 DISTRIBUTION AND EXCRETION OF PLUTONIUM AT REMOTE PERIODS AFTER ADMINISTRATION TO DOGS. T. N. Rysina and R. A. Erokhin. p.12-18 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 15 adult dogs weighing 18 to 28 kg, with 4 i.v. injections of plutonium nitrate (pH 2.0) at monthly intervals. The total dose was 0.2 μC/kg b.w. Seven dogs were also subjected to a daily gamma irradiation of 10r during 5 months. The distribution of plutonium was studied within 3 to 54 months. The plutonium excretion was examined continuously for 21 months. The determination of plutonium in tissues and excretions was performed by incineration with subsequent application of a carrier and radiometric method. 73% of the injected plutonium was still present in the organism 3 months after administration — 40% in the bones and about 30% in the liver. The excretion rate varied for the various organs. The effective half life period for the bones was calculated to be equal to about 4000 years, whereas no regularity was found for the liver. The greatest excretion rate was found within the first 3 to 4 days (1.42 to 0.19%/24 hours). The quantities excreted by the kidneys were the same as those excreted in feces during the first 6 months, but one and a half to twice as much later on. Gamma irradiation did not affect the distribution nor the excretion rate of plutonium in dogs. (OTS)

30271 THE TOXICOLOGIC CHARACTERISTICS OF SODIUM-PLUTONYLTRIACETATE AND ITS DISTRIBUTION IN RATS. Yu. A. Belyaev, N. I. Elkina, V. V. Konstantinova, and I. A. Tseveleva. p.19-22 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 260 rats and 49 control animals weighing 120 to 150 g. The doses of freshly prepared, i.p. injected plutonium salt (pH = 6.5) were 21, 11, 6.3, 3.3, and 1.6 μC/kg b.w. Three animals from each dose group were sacrificed at various time intervals after injection and their organs were examined for the presence of plutonium. The results of the histologic examination are reported by A. P. Nifatov in a separate article. The blood picture was studied in 10 animals of each group on the 1st, 2nd, and 3rd week and 1st, 2nd, 3rd, and 6th month after injection. The determination of plutonium in the organs was carried out by Yu. A. Belyayev's method. It was found

that the distribution of $NaPuO_2(CH_3COO)_3$ in the various organs was very much the same as that of other plutonium compounds. The deposits in the bones of the plutonium compound studied accounted for 50 to 60% of the injected dose, but decreased gradually down to 27% 18 months after the injection. The distribution of Pu in the organism was independent of the dose. The doses of 3.3 and 1.6 μC/kg b.w. were the most carcinogenic, whereas the latter dose did not affect the average life span of the rats. (OTS)

30272 THE MICRODISTRIBUTION OF PLUTONIUM IN THE LIVER OF RABBITS AND RATS. V. K. Lemberg and A. P. Nifatov. p.23-31 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 48 rabbits and 44 albino rats. The former received a single dose of 7 μC/kg b.w. of plutonium nitrate (pH = 2.0) intravenously and the latter were given the same dose i.p. In addition, a single dose of 3 μC/kg b.w. of sodium plutonyl-triacetate (pH = 6.5) was injected i.p. to 12 albino rats. The rabbits were sacrificed by air embolism 1, 3, 7, 14, 30, 90, 135, and 180 days after the injection. Nine rabbits died during that period of time. The rats were decapitated 6 and 12 hours, and 1, 3, 7, 14, 30, 45, 60, 90, and 210 days after the injection. The rats which received the complex salt of plutonium were sacrificed 14, 30, 90, and 365 days after the injection. The liver was fixed in 10% formalin solution, embedded in celloidin-paraffin and cut into sections 5 μ thick. Autoradiographs were prepared according to the method of Ye. V. Erleksova and Evans. Exposure time was 4 to 8 weeks in a refrigerator. Staining was done with Weigert's hematoxylin. It was found that Pu was accumulated mainly in the reticulo-endothelial system elements of the liver. The complex salt of plutonium was distributed relatively evenly in all the liver tissue elements and was present in lesser amounts than the other plutonium compounds. There was a difference in the dynamics of the microdistribution of plutonium nitrate between the rats and the rabbits: it was diffusely distributed during 6 to 12 hours after the injection in the rats and subsequently accumulated in Kupfer cells and macrophages (1 to 210 days), whereas in the rabbits it appeared in high concentration in the RES elements of the liver already 1 day after the injection. (OTS)

30273 HISTOAUTORADIOGRAPHIC DATA ON THE DISTRIBUTION OF PLUTONIUM IN THE BONES OF RATS AND RABBITS. V. K. Lemberg and Z. M. Bukhtoyarova. p.32-40 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 44 albino rats weighing 160 to 200 g and 35 rabbits weighing 2.5 to 3.5 kg. A single dose of plutonium-239 nitrate (7 μC/kg of the radioisotope) was administered i.p. to the rats and i.v. to the rabbits. The rats were decapitated 6 and 12 hours, 1, 3, 7, and 14 days and 1, 1½, 2, 3, and 7½ months after the injection; the rabbits were sacrificed by air embolism 1, 3, 7, and 14 days and 1, 3, 4, 5, and 6 months after the injection. The bones were decalcified and sectioned for historadioautographs. The decalcification was carried out with Ebner's fluid, which causes only a minimal loss of Pu. Histoautoradiography was performed according to Evans and Ye. V. Erleksova. The exposure time was 4 and 8 weeks. The sections were stained with Weigert's hematoxylin. It was found that plutonium nitrate was retained in the bones mainly in the endosteum, periosteum, and bone marrow and to a lesser extent in other bone trabecules. The distribution of plutonium in bone tissue differed according to the animals species: the maximal Pu content in the bone marrow of rabbits was noticed 7 days to 4½ months after injection; in rats the maximum was reached on the 3rd day, after which a gradual decrease was observed. In the rabbits, unlike the rats, a marked concentration of Pu in the RES cells of the bone marrow was observed. The affinity of Pu to the endosteum and periosteum, however, was equally marked in both the rats and rabbits, but it reached a constant level on the 3rd to 7th day in the rats, whereas its concentration increased steadily till the 6th month in the rabbits. (OTS)

30274 THE TRANSMISSION OF PLUTONIUM TO THE OFFSPRING. T. N. Rysina and I. A. Tseveleva. p.41-4 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 17 puppies of varying ages, which were born at different times after the administration of plutonium to the dogs. Plutonium nitrate was administered i.v. four times at intervals of one month. The total dose of Pu was 0.2 μC/kg b.w. The liver and the bones were examined for their Pu contents, which was expressed by the specific activity as percentage of the amount of the injected Pu to the mother. It was found that the placenta was only slightly permeable to plutonium, probably due to its high atomic number and to its stable absorption to tissues. The specific activity in the tissues of newborn puppies was about 10^{-5} to 10^{-6} (% of the dose administered to the mother). The Pu concentration in the tissues of the puppies decreased steadily and was at the age of 3 to 7 months only 0.05 to 0.02 of that found in newborns. The specific activity in the bones of the puppies was higher than in the liver, contrary to the picture observed in the adult dogs. (OTS)

30275 CHEMICAL FORMS OF PLUTONIUM (Pu^{239}) IN THE LIVER AND SPLEEN OF RATS. Yu. A. Belyaev. p.45-51 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on the liver and spleen of rats which were injected i.p. with either plutonium nitrate (pH = 2.0) or the citric acid complex (pH = 6.5). The dose of plutonium was 3.6 to 4.9 μC/kg b.w. Acid soluble fractions, lipids, nucleic acids, and proteins were separated from the organ homogenates by the method of Schneider and by that of Davidson. Globulins, albumins, and residual proteins were separated from the liver by the method of Lak too. The nuclei were separated from the cytoplasm by repeated extractions with physiologic solution at pH = 6.0 to 6.2. The amount of plutonium was determined by the author's method. It was found that plutonium in the liver was mainly bound to proteins. About 50% of Pu in the liver was bound to cytoplasmic globulins. The distribution in the nuclei was as follows: 17 to 24% was bound to DNA, 12 to 16% to acid proteins, and 1.5 to 4.0% to residual proteins. The Pu contents of the liver proteins were the same during 2 months after the injection; thus the chemical form of the injected Pu did not affect this phenomenon. In the spleen there was a lower concentration of Pu in the DNA fraction (5 to 8%) than in the liver. The Pu complex with DNA was more stable than that with RNA, probably due to the high polymerization of the former. (OTS)

30276 PLUTONIUM CONTENTS IN PROTEIN FRACTIONS OF BONES. I. A. Tseveleva. p.52-5 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 68 female rats weighing 160 to 180 g and on 2 rabbits weighing 3000 g. Plutonium (in the form of citric acid complex) was injected i.p. at a

dose of 1.9 μC per rat. The pH of the plutonium-citric complex was 6.0. The animals were sacrificed 7 to 14 days after the injection. The rabbits received 7 μC/kg b.w. of Pu nitrate (given i.p.) and parts of the diaphysis of the femur were analyzed 30 days after the injection. The bones were defatted, decalcified, and minced to powder. The organic matrix was then separated by the method of Stacy to the following fractions: 1) autoclaving soluble proteins, but not precipitating, with trichloracetic acid (TCA); 2) autoclaving soluble proteins which precipitate with TCA; 3) proteins not going into solution after autoclaving. Another method, of Eastoe and of Slack-Neuberger which did not involve autoclaving was also employed. It was found that 90% of the Pu complex was bound to the organic matrix of the diaphysis in rats and rabbits. All the protein fractions of the bones contained plutonium, 65 to 80% were bound to collagen, 15% to albuminoids, 4% to mucoids, and 5% to residual proteins. The Pu-binding capacity per 1 mg of nitrogen of the metabolically active proteins (albuminoids) was 4 to 10 times as great as that of collagen and residual proteins. It is considered that SO_3^{2-} groups of the chondroitinsulphate participate in the Pu binding, since the relative specific activity of mucoids was twice as great as that of collagen. (OTS)

30277 EFFECT OF PLUTONIUM ON UREA SYNTHESIS AND ARGINASE ACTIVITY IN RATS. V. V. Konstantinova. p.63-5 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on female albino rats weighing 150 to 160 g. Plutonium nitrate was administered i.p. (20 μC/kg b.w.). 80 to 90% of the animals died after 6 months following such a dose of Pu. The rats were decapitated after 2 and 4 months and the urea synthesis was determined on liver slices. The arginase activity was determined on liver slices as well as with 1-arginine monochloride as a substrate (20 mg for each test). The urea formed was subjected to the action of urease. The rate of urea synthesis and the activity of arginase were expressed in micromoles of ammonia/1 g of liver. The Pu contents in livers of the experimental animals were determined as well. The administration of plutonium nitrate (20 μC/kg b.w.) to rats brought about a decrease in urea synthesis of 32% after 2 months and of 43% after 4 months. There was a decrease of 18% in the activity of arginase 2 months after the administration of Pu. (OTS)

30278 THE EFFECT OF PLUTONIUM ON THE CONTENTS AND SYNTHESIS OF NUCLEIC ACIDS IN THE LIVER OF RATS. V. V. Konstantinova. p.66-73 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 136 rats weighing 120 to 160 g. Plutonium-239 nitrate was administered i.p. at doses of 20-, 6.2-, 3.7-, and 1.9 μC/kg b.w. The animals were sacrificed by decapitation 1 and 2 weeks, and 1, 2, 6, and 12 months after the administration of Pu. A neutral $Na_2HP^{32}O_4$ solution (4 to 6 μC/100 g b.w.) was administered 4 hours prior to decapitation in order to determine the rate of nucleic acid synthesis. It was found that 20 μC/kg markedly increased the amount of RNA phosphorus and its specific activity as well, 1 and 2 months after the injection. There was an increased rate of P^{32} incorporation into DNA after the administration of 20 μC/kg during the entire period of the experiment. The concentration of P in DNA was lower than in the controls beginning with the 2nd week. In cases of chronic plutonium injuries the greatest changes in nucleic acid metabolism were found after the administration of 6.2 μC/kg. Both the P contents and incorporation rate into RNA and DNA were increased within a period of 9 months. (OTS)

30279 THE EFFECT OF PLUTONIUM ON THE METABOLISM OF NUCLEIC ACIDS IN THE LIVER AND BONE MARROW OF RABBITS. R. E. Libinzon and V. V. Konstantinova. p.74-9 of "Plutonii-239; Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

Experiments were carried out on 54 rabbits, 6 to 8 months old. Plutonium nitrate (7 μC/kg b.w., pH = 2) was injected i.v. and the animals were sacrificed 1, 3, 7, and 15 days and 1, 3, 4½, and 6 months after the injection of Pu. The amount of the nucleic acids was determined in the liver and bone marrow according to Davidson's modification of the Schmidt-Thannhauser's method. The concentration of phosphorus in RNA and DNA of the liver increased by 50% and 37.5%, respectively, after one week, and the amount of DNA decreased by 21% after 6 months. The RNA phosphorus concentration in bone marrow was elevated during the entire period of the experiment. The DNA concentration was increased by 21% and 25% after one week and one month, respectively, and decreased slightly 6 months after the injection of Pu. The mean RNA and DNA values, calculated per nucleus, increased to a maximum 4½ months after the injection. A distinct increase in RNA and DNA contents of bone marrow cells was noticed on the 30th day. The specific activity of RNA in the liver increased beginning with the 3rd month and the rate of DNA synthesis increased to maximum values (7.1 times the normal) 6 months after the administration of Pu. The specific activity of RNA and DNA in bone marrow was markedly lower after one week and increased again on the 3rd month. (OTS)

Fallout and Ecology

30280 (CONF-65-6) THE DISTRIBUTION AND PHYSICAL-CHEMICAL NATURE OF FALLOUT. Joshua Z. Holland (Division of Biology and Medicine, AEC). 32p.

From Federation of American Societies for Experimental Biology Meeting, Atlantic City, N. J., Apr. 1963.

Research on fallout is reviewed. Topics covered include: formation of fallout particles, radionuclide composition of fallout, transport of nuclear weapons debris, mechanisms of distribution of radioisotopes in the atmosphere and from the atmosphere to the surface of the earth, distribution of radioisotopes in food chain, physical and chemical form of the radioisotopes, effects of precipitation on fallout deposition, and behavior of radioiodine. (M.C.G.)

30281 (TID-19104) THE ACCUMULATION OF RADIOACTIVE ISOTOPES BY TROPICAL MARINE ORGANISMS. Annual Report, 1961–1962. Sidney J. Townsley, R. E. Johannes, and Bryant T. Sather (Hawaii. Univ., Honolulu. Hawaii Marine Lab.). Contract AT (04-3)-235. 51p.

Progress is reported in studies on the absorption, tissue distribution, and elimination of injected or ingested radioisotopes by organisms in a marine environment. Data are presented on the metabolism of Sr^{85}, Sr^{89}, $Sr^{90}-Y^{90}$, Y^{91}, and Ca^{45} by tuna and the cichlid fish, Tilapia mossambica; the concentration of Zr^{65} by microcrustaceans and planktonic algae; the adsorption and excretion of Cr^{51} by the crab, Podophthalmus vigil; the effect of salinity on the accumulation and loss of Cr^{51} from solutions by the Sipunculids, Psyscosoma pelma, the Brachiopod, Lingula reevii, and various species of Aspidosiphon; and the in-

fluence of the benthonic amphipod, Lembos intermedius, on the availability of phosphorus to the other trophic levels in an artificial marine ecological system, in which inorganic phosphate labeled with P^{32} was used as a tracer. (C.H.)

30282 RADIOACTIVITY OF WINES FROM THE VINEYARDS OF THE COTNARI REGION. Ioan Luca, Ioan Potec, Valeriu Cotea, Dumitru Filip, and Gheorghe Anghel. Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn., 12: 347-52(1961). (In Rumanian)

The radioactivity of wines is due to the activities of Ra and K^{40}. As no studies were previously carried on on the radioactivity of wines in Rumania, the 1960 vintage wines from the Cotnari vineyards were examined. The β and γ activities of 56 samples, chosen to represent the grapes collected at the 10 most important locations of the area, were measured. The special cylindrical counter, designed for use with liquids, was employed for measuring the activity of the wines, the volume of which was reduced by a factor of 10 to 15. A long counting period of 40 minutes was used, in order to decrease the background error. It was found that the wines had activities ranging from 0.32 to 1.26 mμC/l; the lowest activity was exhibited by the wines from Frîncuşă, the highest by those from Feteasc̆a-type grapes. The place of harvesting also affected the activity of the wines. On the basis of the average K_2O content of the ashes, it is concluded that a part of the radioactivity is due to radioactive isotopes other than K^{40}. (TTT)

30283 OXYGEN ISOTOPIC COMPOSITION OF ECHINODERM FAUNA OF THE NORTH-WESTERN ATLANTIC. A. Longinelli and V. Togliatti (CNEN, Rome). Atti. Soc. Toscana Sci. Nat. Pisa, Proc. Verbali Mem., Ser. A, No. 2, 3-7(1962). (RT/GEO(63)7). (In Italian)

To determine an isotopic temperature scale Epstein et al., (1951) used several living Molluscs such as Brachiopods, Gastropods, and Pelecypods. They mentioned that Echinoderms and Corals were not used because some preliminary results indicated the possibility of a biological fractionation effect of the oxygen isotopes during the deposition of the calcium carbonate shell. As far as we know, further measurements on corals confirmed this hypothesis. On the contrary only very few measurements (unpublished) have been made on Echinoderms; these results cannot be considered conclusive. Living Echinoderms and Molluscs from a small benthonic fauna collected in 1961 on the Newfoundland Great Bank were measured. The depth was about 80 m., the approximate position 46°02′ N 51°33′ W. This research was made in order to check whether there was a significant difference of oxygen isotopic composition between the calcium carbonate of Echinarachnius parma and of some Molluscs grown contemporaneously. The chemical preparation of the samples was made following the method of Epstein et al., (1953). Because of their high content of organic matter, the samples were roasted for two hours under purified helium flow. Measurements were made by means of an Atlas M 86 dual collector mass spectrometer. Due to the large amount of organic matter, the reproducibility was ±0.20‰. From the results, it is possible to conclude that there were no biological isotope effects during the deposition of the calcium carbonate in the Echinoderms and that, at least in this case, deposition took place in isotopic equilibrium with the surrounding water. The measurement of a bottom water sample collected in the zone considered gave a δ value of −1.3. From this value we can calculate a t value of about +4°C for the average of the Echinoderms. This temperature looks reasonable if compared with the observed water temperatures which range from about 0°C to about +4°C in this zone. (auth)

30284 Sr^{90} CONTENTS OF SOILS AND PLANTS FROM THE TERRITORY OF THE DDR IN 1961. H. Reissig (Technische Hochschule, Dresden). Kernenergie, 6: 231-8(May 1963). (In German)

The investigations begun in 1960 on the Sr^{90} content of soils and plants were continued in 1961. The cumulative Sr^{90} content in soils had neither increased nor diminished compared to 1960. The occurring fluctuations lie for grass land and surface soil in the domain of the method and sampling errors. The Sr^{90} contamination of various plants and plant harvest products likewise did not deviate essentially from the results obtained in 1960. The relation ascertained in 1960 between the soil and plant contaminations was confirmed in 1961. The Sr^{90} contamination of the vegetation occurred chiefly by absorption through the root systems. The amount of surface contamination with Sr^{90} in comparison with the total Sr^{90} content in grass samples was evaluated for 1961 as an average of 27%. (tr-auth)

30285 RESEARCH ON THE PRESENCE OF Sr IN MARINE PLANKTON IN RELATION TO THE ECOLOGY OF ACANTHARIA. Bruno Schreiber, Elsa Bottazzi-Massera, Ada Fano-Schreiber, Franca Guerra, and Laura Pelati (Universitâ, Parma, Italy). Pubbl. Staz. Zool. Napoli, 32: 400-26(1962). (RT/BIO(63)12). (In Italian)

The possibility is suggested that Acantharia, because of their specific accumulation of strontium, may be involved in the problems concerning the fixation and circulation of its radioactive isotopes. The chemical and mineralogical structure of the spicules of Acantharia is shown through radiographic analyses with the Weissenberg method and was found to be "monocrystals" of celestite. A correlation between the total content of strontium in plankton and the presence of Acantharia is shown, and the factors possibly affecting this correlation are discussed. A first report of the species found and their relative frequency is given, and episodes of "flowering", that is an absolute prevalence of a single species, are described. The different situation presented by Tyrrhenian and high Adriatic seas in relation to the distribution of Acantharia is pointed out, and the possible causes are suggested. The effects of Tyrrhenian and high Adriatic seas in relation to the distribution of Acantharia are related. (auth)

Radiation Effects on Living Tissues

Refer also to abstracts 30020, 30021, 30027, 30029, 30030, 30033, 30039, 30055, 30078, 30143, 30215, 30216, 30217, 30218, 30220, 30221, 30222, 30223, and 30224.

30286 (CONF-29-1) AN APPROACH TO THE CHARACTERIZATION OF STEM CELLS IN MOUSE BONE MARROW. G. Cudkowicz, A. C. Upton, L. H. Smith, D. G. Gosslee, and W. L. Hughes (Oak Ridge National Lab., Tenn. and Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [W-7405-eng-26]. 25p.

From Conference on Modification of Radiation Injury by Bone Marrow Transplantation and Chemical Protection, New York, December 1962.

The competence of bone marrow to promote recovery of hemopoietic function in irradiated recipient mice was observed to decrease on serial transplantation. Evidence is presented that the protective ability of the serially transplanted marrow can be reconstituted by addition of lymphoid cells harvested from normal lymph nodes. The nature and cellular basis of variations in the proliferative capacity

of a given marrow cell population in the course of syngeneic (isologous) transplantation were investigated. A quantitative measure of this capacity of the marrow was obtained by determining the ability of the marrow to form colonies in the spleens of irradiated recipient mice and by measuring incorporation of I^{131}-labeled iododeoxyuridine, a specific desoxyribonucleic acid precursor, in such spleens. The proliferative capacity, as evaluated by these techniques, was related to the cellular constitution of the marrow, as determined by differential cytologic analysis of marrow smears, in an attempt to identify the responsible stem cells. (auth)

30287 (NP-12977) ANNUAL PROGRESS REPORT [ON RADIOBIOLOGY], JULY 1, 1962–JUNE 30, 1963. Edward J. Huycke, Jon W. Blumenstock, and Erich Oberhausen (Army Medical Research Unit No. 1, Landstuhl Army Medical Center, Germany). 23p.

Results of whole-body counting of a normal population showed increased radioactivity due to fallout from July 1962 to July 1963. Over 2000 persons were measured for content of Cs^{137} and natural potassium. Results are included from whole-body post-operative measurements of patients with thyroid carcinoma, potassium measurements of patients with cirrhosis of the liver, whole-body fat determinations using tritiated water as a tracer, and miscellaneous clinical studies including I^{131}-Triolean absorption studies, I^{131}-Hippuran scintillation rhenogram studies, and studies on vitamin retention using Co^{60}-labeled vitamin B_{12}, and measurements of deposited uranium, radium, thorium, and other radionuclides in man. Samples of rain water and milk were measured for radioactivity from fallout products. (C.H.)

30288 (TID-19010) MATHEMATICAL MODELLING FOR THE MORTALITY EFFECTS OF VARIOUS RADIATION DOSAGE SCHEDULES. First Report. A. S. Iberall (Rand Development Corp., Cleveland). July 1963. Contract AT(11-1)-1254. 82p.

Data on the biological effects of radiation were accrued from laboratory and field animal tests, clinical therapy, radiation accidents, the accidental exposure of the Marshallese population, and the exposure of the populations of Hiroshima and Nagasaki to radiation. Symptoms and effects studied included chromosome damage causing hereditary changes, induction of cancer, debilitating effects, and shortening of the life span. The data will be used in the preparation of a mathematical model of the effects of radiation dose rate on life span. (C.H.)

30289 (TID-19049) STUDIES ON BIOLOGICALLY ACTIVE AMINES. Period reviewed: 1957–1963. Yutaka Kobayashi (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). July 10, 1963. Contract AT(30-1)-2085. 6p.

Progress is reported in studies on the physiological role of histamine, using C^{14}-histamine and the isotope dilution technique. Topics discussed include enzyme systems involved in histamine metabolism, gastric secretion of C^{14}-histamine in dogs, reaction mechanisms involved in the binding of histamine by heparin, the metabolism of histamine in normal and schizophrenic subjects, and histamine metabolism in irradiated rats. A list is included of publications prepared during the period covered by this report. (C.H.)

30290 (TID-19058) THE EFFECTS OF PRENATAL RADIATION ON DEVELOPMENT IN ANIMALS. Robert L. Brent (Jefferson Medical Coll., Philadelphia). [nd]. Contract AT10(30-1)-2071. 51p.

Recent findings on the effects of prenatal radiation on development in animals are reviewed. Topics discussed include the effect of preimplantation irradiation, the importance of maternal irradiation in the production of malformations and embryonic death, the postpartum effects of prenatal irradiation, and the relative sensitivity of the embryonic and adult cell and the relation of sensitivity to the late effects of irradiation. (91 references.) (C.H.)

30291 (UR-626) PATHO-PHYSIOLOGIC ASPECTS OF RADIATION NEPHRITIS IN DOGS. John G. Maier and George W. Casarett (Rochester, N. Y. Univ. Atomic Energy Project). Apr. 8, 1963. Contract W-7401-eng-49. 189p.

A study has been made of the effects of single exposure, localized irradiation of the kidneys in beagle dogs at 500, 1,000, and 2,000 rad using 220 Kv x ray. Both functional and morphological parameters were investigated with animals being sacrificed at six months post-irradiation. Unilateral and bilateral in situ kidney irradiation were given as well as unilateral irradiation of single exteriorized kidneys. The literature of radiation nephritis was reviewed, and the pathogenesis of this disease is discussed. Functional studies indicated hypertension, proteinuria, hematuria, diuresis, decreased urinary concentration, diminished excretory function, nitrogen retention, and anemia. Morphological findings revealed an arteriolonephrosclerosis. The degree of functional and morphological changes at 500, 1,000, and 2,000 rad irradiation to single or bilateral kidneys in situ and single kidneys having subcutaneous exteriorization were correlated. (auth)

30292 (WRU-110) REVIEW OF RADIATION PNEUMONITIS. J. Chandler Smith (Western Reserve Univ., Cleveland). Feb. 25, 1963. Contract W-31-109-Eng-78. 26p.

Radiation pneumonitis is a condition that develops in some patients following radiotherapy of tumors located in the chest and neck regions. This complication usually develops within 6 months after irradiation and may subside, or develop into progressive fibrosis. The clinical features of radiation pneumonitis are reviewed, the radiographic patterns are defined, and the pathologic lesions are described. It is concluded that further research is needed to determine why some patients develop radiation pneumonitis while others do not, and why the disease process subsides spontaneously in some patients but progresses relentlessly in others. (C.H.)

30293 (JPRS-20210) DATA ON THE STUDY OF GASTRO-INTESTINAL TUMORS INDUCED BY RADIOACTIVE CERIUM (Ce^{144}). G. A. Levedeva. Translated from Arkh. Patol., 25: No. 5, 40-4(May 1963). 7p. (OTS-63-31307)

A study was made of tumors of the gastrointestinal tract in rats induced by the administration of 9 to 18 μc/gm of Ce^{144}. Neoplasms were detected from 250 to 485 days after administration of Ce^{144} and included adenomas, papillomas, leiomyomas, sarcomas, and carcinomas. The most frequent site of localization of tumors was the large intestine. (C.H.)

30294 TECHNIQUE AND DOSIMETRY OF YTTRIUM 90 THALAMOTOMY. Paul H. Chandall and Joseph L. Westover (Univ. of California Medical Center, Los Angeles). Acta. Radiol. (N.S.), 1: 82-94(Mar. 1963). (In English)

A technique for thalamotomy employing yttrium-90 macrospheres was used in the treatment of Parkinsonism, paralysis agitans, dystonia musculorum deformans, and cerebellar tremors. By utilizing the physical characteristics of beta emitters, to achieve a circumscribed complete

lesion, physical disruptive effects are avoided. The crucial target, the ventrolateral nucleus, is subtended by a 1 cm diameter spherical lesion. Animal experiments showed that fixation of the source is necessary to avoid migration of the head. Twelve patients were treated. Observation of the patients from 4 to 11 months showed that an excellent result can be achieved with few or no side effects. (auth)

30295 HEMANGIOBLASTOMA CEREBELLI—REPORT OF A SIX YEAR SURVIVAL AFTER ROENTGEN THERAPY BY TUMOR OSCILLATION THROUGH A GRID. Hirsch Marks (Harlem Hospital, New York). Acta Radiol. (N.S.), 1: 95-100(Mar. 1963). (In English)

A case of unresectable hemangioblastoma of the cerebellum was treated by oscillation through a grid with 250 electronkilovolts. The patient has been symptom-free for the past 6 years. There was increased selective localization of the radiation energy in the tumor proper and very little in the skin of the scalp. (auth)

30296 IONIZING RADIATIONS AND THE MAMMALIAN EMBRYO. Roberts Rugh (Columbia Univ., New York). Acta Radiol. (N.S.), 1: 101-13(Mar. 1963). (In English)

It was found that the mammalian embryo shows varying reactions to ionizing radiations such that it is always more radiosensitive than is the adult into which it develops, at some stages 100 times as sensitive. After neurogenesis is completed, congenital anomalies of that system are rarely produced, but exencephaly (brain hernia) has been caused by ionizing radiations impinging upon the 2-cell stage of the mouse with an exposure of as little as 10 r. (auth)

30297 BORON-SLOW NEUTRON CAPTURE THERAPY OF GLIOMAS. W. H. Sweet, A. H. Soloway, and G. L. Brownell (Massachusetts General Hospital, Boston). Acta Radiol. (N.S.), 1: 114-21(Mar. 1963). (In English)

The most favorable among 140 boron compounds studied in mice, bearing gliomas, were checked for their toxicity in larger animals, and of these the six best were finally assayed in man for use in neutron capture therapy by analyses of tissue uptake during craniotomy and by toxicity and excretion studies in terminal glioma patients. An initial series of 16 patients were irradiated, using intravenous injection of paracarboxybenzene boronic acid made with boron-10. Dosimetric and operative techniques are described. Treatment of a second series has begun, using an even less toxic compound, containing far more boron and suitable for intracarotid injection following temporary occlusion of both the common carotid arteries. (auth)

30298 DEMONSTRATION OF CEREBRAL RADIATION DAMAGE WITH RADIOACTIVE SUBSTANCES. Sigurd Wende (Freie Universität, Berlin). Acta Radiol. (N.S.), 1: 122-8(Mar. 1963). (In German)

Localized roentgen irradiation of the brain causes increased permeability of the blood-brain barrier which is demonstrable by means of gamma encephalography. (auth)

30299 EFFECTS OF WHOLE-BODY X-IRRADIATION ON ELECTROSHOCK SEIZURE RESPONSES IN DEVELOPING RATS. Antonia Vernadakis and Paola S. Timiras (Univ. of California, Berkeley). Am. J. Physiol., 205: 177-80(July 1963).

Electroshock seizure responses were studied in control and irradiated rats between 8 and 55 days of age. Experimental animals were exposed to 500 r whole-body x irradiation 2 days postnatally. In maturing rats seizure patterns produced by brain stimulation with 50 ma current appear in sequence: hyperkinesia, clonus, forelimb flexion, forelimb extension followed by hind limb flexion, and hind limb flexion followed by hind limb extension. In irradiated rats full flexor-extensor seizure pattern appeared in 50% of animals at 13 days of age, 3 days earlier than in controls. Extension was longer and flexion, clonus, and total seizure were shorter in irradiated than in controls. In both groups durations of clonus and total seizure were related inversely to durations of extension. Duration of flexion decreased and duration of extension increased up to 22nd day of age in all animals. This indicates increased neuronal activity as the brain matures. Also thresholds for minimal electroshock convulsions decreased up to 22nd day of age, further indicating increased brain activity with maturation. Thresholds were significantly lower in irradiated rats than in controls. (auth)

30300 A RAPID METHOD FOR DETERMINING THE RADIATION DOSE IN A FROZEN AND IRRADIATED WHOLE EGG. H. Gaisch (Reaktorzentrums Seibersdorf, Vienna). Atompraxis, 9: 236-7(June 1963). (In German)

A procedure is described for determining the radiation dose in a frozen, irradiated whole egg. The procedure is based on the determination of aldehydes. (C.H.)

30301 THE USE OF IONIZING RADIATIONS FOR INCREASING GENETIC VARIABILITY IN CULTIVATED PLANTS. Renzo Scossiroli (Università, Pavia, Italy). Atti Accad. Econ.-Agrar. Georgofili Firenze, (7), 9: 1-23 (1962). (RT/BIO(63)10). (In Italian)

On the basis of results obtained by irradiation of Drosophila populations, experiments were started on maize populations treating with x-rays the male inflorescence and on wheat populations treating dormant seeds. It was possible to demonstrate that irradiation increases the genetic variability for a series of morphological and production traits through the induction of mutations in the hereditary units responsible for such traits. Experiments are in progress to test whether such new genetic variability might be useful for determining or improving new progress under selection for high productivity, as it has been possible in Drosophila populations. Experiments were performed also to test whether it is possible to modify, by means of ionizing radiations, the combining ability of inbred lines in corn. X-ray treatments were applied to the tassel of a homozygous population. Different lines were derived from the population with repeated selfing and tested for combining ability in crosses to WF 9. Some of the lines possess low combining ability, while others gave good evidence of high combining ability when crossed to the common tester WF 9, giving evidence that combining ability of the parental homozygous population was modified as a consequence of the radiation applied to the male gametes. (auth)

30302 EFFECT OF IONIZING RADIATION ON PROTEIN SYNTHESIS. P. Cammarano (CNEN, Rome). Atti. Congr. Nazl. Radiobiol. Med., VI, Trieste, 1962, 26-8 (1963). (RT/BIO(63)7). (In Italian)

After a short review is presented of the activating mechanisms involved in amino acid transport and incorporation, data on the action of ionizing radiations on protein synthesis are discussed. Following whole-body x irradiation, the incorporation of labeled amino acids into tissue protein turns out to be either unchanged or increased. On the other hand, an early effect of radiation injury, i.e., uncoupling of oxidative phosphorylations, has been repeatedly reported. Since there is wide evidence that amino acid incorporation requires ~P, mostly supplied by means of oxidative phosphorylations, the above findings raise definite questions. Actually, it is well known that uncoupling agents markedly depress the uptake

of labeled amino acids in vitro. A picture and a problem substantially similar to those described after x irradiation, occur in cloudy swelling brought about by different agents, such as dinitrophenol or bacterial toxins. Under this latter condition, an uncoupling of oxidations from phosphorylations is paralleled by an increase of aminoacid incorporation. Enlargement of cells and swelling of mitochondria have been reported as early effects of radiation injury. (auth)

30303 EFFECT OF RADIATION ON PURIFIED ENZYMES AND PROTECTIVE ACTION OF SULFANILAMIDE DISULPHIDE. L. Brighenti and A. Falaschi. Atti Uffic. Congr. Sci., Sez. Nucl., 1960, 573-82(1962). (RT/CHI(62) 15). (In Italian)

Previous research on the inactivation of pure compounds of lactic dehydrogenase of yeast by means of ultraviolet and roentgen radiations was extended to other purified enzymes extracted from animal tissues; liver alcohol dehydrogenase, heart lactic dehydrogenase, and pancreas ribonuclease. It was possible to confirm that the inhibitory reaction caused by radiation shows a monomolecular trend, using both ultraviolet and roentgen radiation, and that it depends on the free radicals produced in the irradiated solution. The inhibitory effect of ultraviolet radiation is remarkably reduced by the presence of compounds of the type bis (2,2-amino-4,4'-sulfanilamide)-disulphide at concentration ranging between 10^{-4} - 10^{-5} M. In these conditions it is possible to observe a decrease of the yield of the inactivation reaction. Also the inhibitory effect of roentgen rays is reduced by the disulphide. (auth)

30304 ULTRAFRACTIONATION AND RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST ELECTRONS. INVESTIGATION ON DROSOPHILA EMBRYOS OF DIFFERENT DEVELOPMENT STAGES. Friedhelm Oberheuser and Hans A. Kuenkel (Universität, Hamburg and Institut für Strahlenbiologie, Hamburg). Biophysik, 1: 11-19(1963). (In German)

Experiments were carried out with a 15-Mev betatron. By means of a special electronic device it was possible to quench radiation pulses in the injector of the accelerator. In this way the frequency of radiation pulses was varied between 2 and 50 ppsec. The ultrafractionated radiation was compared with the continuous gamma radiation of a 1000-curie Co^{60} source. The influence of ultrafractionation on the relative biological efficiency of fast electrons was tested in embryos of Drosophila melanogaster of different stages of development. In these experiments either the average dosage rate or the dose of the particular radiation pulses was kept constant. Dose-effect curves showed a significant influence of the pulse frequency on the percentage of killed eggs, which may be due to the existence of an effect of recovery. (auth)

30305 ON THE INTERPRETATION OF THE DOSE-EFFECT RELATION IN RADIOBIOLOGY. O. Hug and A. Kellerer (Universität, Munich and Institut für Strahlenschutzforschung der Gesellschaft für Kernforschung, Neuherberg, Ger.). Biophysik, 1: 20-32(1963). (In German)

The random character of the cellular radiation effect does not have to depend always on the variability of radiation sensitivity or on an inhomogeneous distribution of the absorbed energy on the units of an irradiated population or their "bombarded region," but can also be caused by "dispersed injuries" that increase continuously with dose in all units, if these increase the inherent lability of the living system. The beginning "critical occurrence" that decides the commencement of the test reaction, therefore, does not have to be furnished absolutely by the energy absorption, but can lie in a later member of the causal chain. A characteristic of the survival curve was its slope, whose size is designated as reactivity, in semi-logarithmic construction. It showed that the reactivity can increase with dose. If the reactivity, with increasing dose leads to an end value, then this can depend on the fact that one of the vital objects inherent in the compensation capability is exhausted at this dose. In some cases the biochemical nature of such a capability was plain. (tr-auth)

30306 ON THE KINETICS OF RADIATION EFFECTS. A. Kellerer and O. Hug (Universität, Munich and Institut für Strahlenschutzforschung der Gesellschaft für Kernforschung, Neuherberg, Ger.). Biophysik, 1: 33-50(1963). (In German)

Models and formulas for the consideration of the kinetics of radiation effects are presented. A generalized representation of the impact theory is given. Alternatives to this theory are listed. Experimental results demanded a mathematical treatment, which considered from the beginning the physiological kinetics as well as the radioinduced events in vital objects. Parameters such as time factors and relative biological effectiveness are included in the formulas. The usefulness of the model developed was shown in a study of radiation effects on enzyme systems in vivo. (M.C.G.)

30307 OXYGEN EFFECT AFTER CONVENTIONAL X-RAY AND HIGH-ENERGY ELECTRON IRRADIATION IN A RADIOINDUCED MODIFICATION (PHENOCOPY). H. Fritz-Niggli, E. Diener, and P. Schleuss (Strahlenbiologischen Institut des Kantonsspitals, Zurich). Biophysik, 1: 51-9(1963). (In German)

By irradiation of 5-hr pre-pupa of Drosophila melanogaster the wind placement of the adult flies was changed in the sense of spreading. The origin of this radioinduced modification, which represents at the same time a phenocopy, is dependent on genetic factors, since two different inbred strains were distinguished from one another by their radiation sensitivity. The biological effectiveness of electrons and photons were compared. Irradiation in pure N_2 hindered drastically the origination of the anomaly (a reduction from 98% injuries by 5000 r of 30-Mev electrons to 5%). No difference in protective effect was observed for 30-Mev electrons or 180-kev photons. The oxygen effect was postulated to be a blocking of processes in the macromolecular region. (M.C.G.)

30308 RADIATION DAMAGE TO GROWING BONE: THE EFFECT OF X-RAY DOSES OF 100 TO 1,000 r ON MOUSE TIBIA AND KNEE-JOINT. Jocelyn Blackburn and A. B. Wells (Strangeways Research Lab., Cambridge, Eng. and Guy's Hospital, London). Brit. J. Radiol., 36: 505-13 (July 1963).

The effects of localized single doses of x rays on Ca^{45} uptake and growth of the mouse tibia and knee-joint, and on the histology and mitosis of the epiphyseal cartilage plate were studied. Doses of 1,000 r and 500 r caused marked histological changes from which recovery slowly occurred. Ca^{45} uptake was temporarily depressed after these doses, but not significantly after 250 r and 100 r. Stunting of growth of the tibia appeared rapidly after 1,000 r but only very slowly after 500 r. There was an almost complete inhibition of mitosis in the cartilage plate shortly after irradiation: this recovered rapidly at first but was not complete until about three weeks after irradiation. It is concluded that some cells degenerate having successfully completed the first mitotic cycle. These ob-

servations are discussed in relation to each other and to other published work on the effects of similar doses on growing bone. (auth)

30309 SPECTRUM OF THE RADIATION FROM A COBALT 60 TELETHERAPY UNIT. J. W. Scrimger and D. V. Cormack (Univ. of Saskatchewan, Saskatoon, Can. and Saskatoon Cancer Clinic, Saskatoon, Can.). Brit. J. Radiol., 36: 514-21(July 1963).

The spectrum of the degraded radiation in the beam from a Co^{60} therapy unit was determined from measurements of the once-scattered radiation at various angles. The therapy unit contained a source 2.5 cm diameter and 0.65 cm thick in a standard capsule. The once-scattered spectra were measured with a scintillation spectrometer and corrected using theoretical response functions. Changing the size of the beam from the unit produced very little change in the spectrum indicating that there was little radiation scattered from the inside of the collimating system. For photon energies below 0.5 Mev the measured spectrum agreed with previously reported calculations. (auth)

30310 AN INSTRUMENT FOR THE RAPID MEASUREMENT OF X-RAY FIELD FLATNESS. K. W. Koschel and K. H. Clarke (Cancer Inst., Melbourne). Brit. J. Radiol., 36: 538-41(July 1963).

An instrument is described that was designed for the rapid measurement of $x_T$ray field flatness. The unit was designed for use with 4-Mev linear accelerators but could be used with lower energy x-ray equipment. (C.H.)

30311 CHANGES IN THE OFFSPRING OF FEMALE RATS EXPOSED TO 50 r OF X RAYS WHEN EIGHT DAYS OLD. Dj. Sladić-Simić, D. Pavić, N. Zivković, D. Marinković, and P. N. Martinovitch (Inst. of Nuclear Science "Boris Kidrich," Belgrad). Brit. J. Radiol., 36: 542-3 (July 1963).

Female rats were exposed to 50 r x radiation when 8 days old and mated when 2 months old with normal males. The offspring of 15 out of 17 irradiated females showed a high rate of stillbirths, dwarfism, increased mortality rate, and anemia that persisted through 5 filial generations. (C.H.)

30312 THE EFFECT OF X-IRRADIATION AND SEROTONIN ON Cr^{51} UPTAKE IN MOUSE BONE, MUSCLE, AND BRAIN. P. V. Vittorio and E. W. Wight (Defence Research Chemical Labs., Ottawa). Can. J. Biochem. Physiol., 41: 1525-30(July 1963). (DRCL-405)

In all the tissues studied (duodenum, gastrocnemius, heart, brain, and tibia) serotonin treatment prior to x irradiation produced a smaller increase and a faster return to corresponding control Cr^{51} values than in unprotected x irradiated mice. It is suggested, with certain exceptions, that this increase in Cr^{51} and return to normal, whether in protected or non-protected x irradiated mice, is indicative of the amount of damage or subsequent repair and the time of recovery in the tissues studied. (auth)

30313 THE EFFECT OF ULTRAVIOLET LIGHT ON MITOCHONDRIA. VII. RESTORATION OF DINITROPHENOL-ACTIVATED ADENOSINETRIPHOSPHATASE BY VITAMIN K_1 FOLLOWING INHIBITION BY FAR-ULTRAVIOLET LIGHT. Robert E. Beyer (Tufts Univ., Boston). Can. J. Biochem. Physiol., 41: 1669-71(July 1963).

The effect of ultraviolet light on enzyme activity in rat liver mitochondria was studied. Restoration of dinitrophenol-activated adenosinetriphosphatase by vitamin K following inhibition by far-ultraviolet light is reported. (C.H.)

30314 ACTION OF GAMMA RAYS ON THE FIRST STAGES OF DEVELOPMENT OF THE NICOTIANA RUSTICA EMBRYO. Marcel Devreux and Gian Tommaso Scarascia Mugnozza (CNEN, Rome). Caryologia, 15: 279-91(1962). (RT/BIO(63)9). (In Italian)

Four plants of Nicotiana rustica var. Kolmak were subjected to gamma irradiation from Co^{60} (175-curie source) in order to obtain preliminary data on the action of gamma rays on the Nicotiana proembryo. The total doses delivered were: 6,000 r/16 hr, 8,000 r/17 hr, 10,000 r/16 hr and 10,000 r/2 hr 40 min. Several different growth anomalies of the irradiated embryos were observed, namely: development inhibition, vacuolization, disorganization, formation of lacunae, plasmolysis, and degenerations. Measurements of the growth of the irradiated embryos were taken. Endosperm formation seemed to be particularly affected by radiation: the division of the endosperm nuclei was not followed by cytokinesis or membrane formation was incomplete. Large polyploid nuclei were produced by endopolyploidy and endosperm structure was completely disorganized. In the weakly irradiated proembryos the effects on the growth of the embryo at its first stages of development were negligible, while at the dose 10,000 r/2hr 40 min inhibition of development was observed during the first three days following treatment. Almost all seeds obtained after the various irradiations resulted to be empty; only 3.17% of the seeds obtained after treatment with the highest dose (10,000 r/2 hr 40 min) were able to germinate. (auth)

30315 APPLICATION OF RADIOISOTOPE OF Sr^{90} IN THE TREATMENT OF CERTAIN DERMATOSIS. Jui Shih, Hsi-lan Tseng, Kuo-hua Huang, Ts'eh Lin, and Pao-tsung Wang. Chung-hua Fang She Hsueh Tsa Chih, 8: 117-20 (1960).

A preliminary report is presented on the application of radioisotope Sr^{90} in the treatment of 10 types of dermatosis including 58 case histories. Sr^{90} was recommended for the treatment of shallow dermatosis as it is incapable of producing alpha rays after beta decay to injure the inner tissues. The low energy beta rays of Sr^{90} are filtered while the beta rays of Y^{90} are utilized to eliminate epidermic absorption. $Sr^{90}(NO_3)_2$ was used in experimental therapy. Dosage determination was based on the P^{32} formula derived by a Soviet expert. Varying dosages ranging from 4 to 27 treatments were given to 30 cases of neurergic dermatitis. In most cases, 10 to 12 treatments were administered twice a week at 18 to 180 rep. Sr^{90} showed therapeutic effect after 2 to 3 treatments. At a total dosage of 800 to 1000 rep itches began to disappear and eruptions subsided in a majority of cases. Clinical results revealed that 23 cases were cured, 4 showed improvement, and 3 were progressing. None failed to respond. Therapeutic responses also showed in other cases such as erythema multiform, cutaneous ulcers, external piles, eczema, grog blossom, and tinea in the hands and feet. Sr^{90} treatment was found superior to the P^{32} x-ray therapy and Chinese herb treatment. The activity mechanism of Sr^{90} in treatment of dermatosis is attributed to the direct function of beta rays on the receptors of skin nerves. This results in the temporary inhibition of nervous impulse conduction, the disappearance of clinical symptoms, and curing of the diseases. Lead, aluminum, and rubber were used in the experimental protection. Results showed that rubber is satisfactory. (OTS)

30316 THE KINETICS OF THE MUTAGENIC EFFECT OF ULTRAVIOLET IRRADIATION ON THE EXTRACEL-

LULAR BACTERIOPHAGE C_D OF E. COLI. A. S. Kriviskii, G. B. Zavil'gel'skii, V. I. Ivanov, and A. M. Lysenko (Inst. of Radiation and Physical Chemical Biology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 150: 399-402(May 11, 1963). (In Russian)

A total of 5×10^{10} C_D bacteriophages were diluted to a concentration of less than 5×10^7 phages per ml in a 0.85% NaCl solution (pH = 7.2), and were irradiated with uv light from a lamp giving 80% monochromatic light with $\lambda = 2537$ Å. The survival of the phages and the number of phage mutants were determined by culturing the irradiated phages with E. coli at 37°C for 18 to 20 hours in the dark. The lysis zone around the mutant phages was considerably smaller in diameter (0.1 to 0.2 mm) than around the wild type of phage (~0.5 mm in diameter). The phage survival was linear with dose up to 10^{-2} at a dose of 350 to 400 ergs/mm^2. The phage became increasingly radioresistant at higher doses. Similarly, the mutation frequency of the C_D phage increased linearly with dose at low dosage, attained a maximum at 350 to 400 ergs/mm^2, and then dropped sharply with subsequent increase in dose. The results indicated that ultraviolet irradiation has a direct effect on the DNA molecules which control the genetic characteristics of an organism. (TTT)

30317 PROPHYLACTIC STIMULATION OF THROMBOCYTOPOIESIS AND DEVELOPMENT OF HEMORRHAGIC SYNDROME DURING EXPOSURE TO IONIZING RADIATION. N. V. Traskunova (Central Research Inst. of Medical Radiology, Ministry of Health, USSR). Federation Proc., 22: T485-7(May-June 1963). (Translated from Med. Radiol., 7: No. 7, p.45, 1962).

Injections of Difacil, a cholinolytic compound, stimulate thrombocytopoiesis in healthy guinea pigs. The administration of repeated courses of Difacil injections (up to and including 4 courses) lead to a more prolonged period of maintenance of the raised platelet count in the peripheral blood. The administration of 2 and 3 prophylactic courses of Difacil injections to guinea pigs irradiated in a dose of 200 r decreases the severity of thrombocytopenia during the course of radiation sickness. The manifestations of hemorrhagic diathesis were less apparent in the guinea pigs that received prophylactic injections of Difacil than in the animals that received irradiation only. Not only does the prophylactic administration of Difacil to guinea pigs before irradiation delay the development of thrombocytopenia and decrease the degree of hemorrhagic diathesis, but it also to some extent prevents the early death of the animals. (auth)

30318 EFFECT OF CULTIVATION TEMPERATURE ON SENSITIVITY OF INFUSORIA TO INJURIOUS ACTION OF X RAYS. N. K. Kovaleva (Inst. of Cytology, Leningrad). Federation Proc., 22: T507-13(May-June 1963). (Translated from Tsitologiya, 4: No. 3, p.306, 1962).

The study of the sensitivity of the infusorian, Paramecium caudatum, to ionizing radiation at different cultivation temperatures revealed obvious differences between infusoria kept at a temperature of 19 to 22° (room temperature) and of those kept at low temperatures, +4° and +5° (cold). The changes in the division rate of infusoria exposed to high dose rates of radiation for 2-min periods were caused, both by the direct action of radiation and by its indirect action, through the ionization and excitation of the water molecules composing the cell body, and not by chemical poisoning by products present in the surrounding aqueous solution. In room temperature infusoria, irradiation by a dose of 75 kr causes a period of 24 hr without division in 70% of individuals. The rate of division varies considerably during the first 2 to 3 weeks after irradiation. Structural disturbances occur in the micronucleus. In some individuals, there is fragmentation of the macronucleus. The cytoplasm becomes vacuolated. Irradiation of room temperature infusoria causes a disturbance of carbohydrate and lipid metabolism, as shown by an increase in the lipid content and a decrease in the glycogen. A period of 5 to 7 days without division is observed in cold infusoria after irradiation. The decrease in the rate of division by comparison with the control infusoria is very small. No changes are apparent in the nuclear apparatus except for a decrease in the size of the nucleoli in the macronucleus. Vacuolation of the cytoplasm occurs. The changes in the glycogen and lipid content after irradiation are less marked in cold than in room temperature infusoria. Unirradiated cold infusoria, when placed in irradiated medium, show greater resistance than unirradiated room temperature infusoria. Our results indicate that infusoria which have become adapted to low positive temperatures possess greater radioresistance than infusoria cultivated at room temperature, which confirms yet again the importance of the physiological state of the organism and of external environmental factors in determining the sensitivity to ionizing radiation. (auth)

30319 ERYTHROBLASTIC MALIGNANCY IN A BEAGLE. A. C. Andersen and R. M. Johnson (Univ. of California, Davis). J. Am. Vet. Med. Assoc., 141: 944-6 (Oct. 15, 1963).

A female beagle, which had been given a total dose of 300 r whole-body x irradiation as part of a long-term study, died 5 yr after irradiation, when she was 5¾ yr old. Necropsy findings included splenomegaly and multiple metastatic foci in the liver, lymph nodes, and lungs. The outstanding histologic finding was the presence of large numbers of neoplastic cells within the lumen of both large and small blood vessels in all major organs. The malignancy apparently originated from bone marrow because of the dense, uniform distribution of anaplastic cells. The medullary sinusoids of lymph nodes were infiltrated with densely packed cells, whereas the cortical sinusoids contained a loose arrangement of cells, as if metastasis had occurred at the medulla. Further evidence of bone marrow origin could be assumed from the rise in erythrocytic elements and depression in myelocytic elements, without a change in lymphocyte count, 4 months before death. The characteristic cell type also gave evidence of its erythropoietic origin. This case suggests a malignancy of erythropoietic tissue that could have been radiation-induced, since such malignancies are rare in domestic animals. (H.H.D.)

30320 FATE OF RADIOACTIVE TIN IN RATS. Shigeko Morimoto and Yoshimasa Yoneyama (Tokyo Univ.). J. Biochem. (Tokyo), 41: 601-8(June 1961).

The absorption, excretion, and distribution of Sn^{113} (as $SnCl_2$ or $SnCl_4$) were studied in rats after feeding and injection. Almost none of the administered Sn was absorbed; only a small part was absorbed and then excreted. More of the injected Sn was excreted in urine than feces. The injected divalent Sn^{113} was accumulated in bone, whereas the tetravalent metal was found mainly in the reticuloendothelial system. High radioactivity was found in the lower intestine shortly after the injection of Sn^{113}. The relatively high Sn^{113} content of the lower intestine in the early period should be studied further to determine whether it results from excretion or retention. No characteristic distribution of Sn among organs was found after oral feeding. In all

cases the adrenals accumulated high radioactivity. Divalent Sn might be deposited in bone in place of Ca ion whereas colloidal tetravalent Sn particles might be captured by reticuloendothelial organs, as in the case of Au and Fe in colloidal solutions. No radioactivity was found in blood 6 hours after injection. (H.H.D.)

30321 THE TREATMENT OF IRRADIATION FRACTURE OF THE FEMORAL NECK. J. W. Leabhart and M. Bonfiglio (Univ. of Iowa, Iowa City). J. Bone Joint Surg., 43A: 1056-67(Oct. 1961).

Treatment of 44 patients with 56 postirradiation fractures of the femoral neck is reported. Of 2612 patients who received pelvic irradiation for carcinoma of the uterine cervix, 40 developed fractures of the femoral neck, an incidence of 1.5%. Sixteen of the 40 patients had bilateral fractures. The average age of the patients was 58.5 yr at the time of irradiation. The average irradiation dose was ~3600 r (parametrial dose), the largest dose being 4235 r. The average interval from irradiation to the onset of pain in the hip was 36.6 months (3 to 240 months) and from the onset of pain to diagnosis, 3 months. Forty-six surgical procedures were performed: 36 as primary treatment and 9 because of failure or complications of the first procedure. The average follow-up time of these patients was 6.9 yr. The presenting complaint was usually spontaneous onset of pain in the groin and medial portion of the thigh. Initially the physical examination often revealed only restriction of internal rotation of the affected hip, and the roentgenograms appeared normal in some instances. Subsequently, a change in bone density was noted at the inferior aspect of the femoral neck, denoting an adduction type of fracture. The displaced fractures resembled the traumatic adduction fractures of the femoral neck seen in patients who had not received irradiation. Acetabular changes were also noted, characterized by marked osteoporosis and occasionally fracture of the acetabulum. Seven methods of primary therapy were used to treat these patients: no treatment, nonsurgical measures (crutches or bedrest), internal fixation, bone-grafting (with and without additional fixation), osteotomy, arthroplasty, and the insertion of a prosthesis. Early in situ internal fixation or internal fixation with bone grafts was the procedure of choice in fractures of the femoral neck secondary to irradiation. Reconstructive procedures, such as cup arthroplasty or insertion of a prosthesis, were effective treatment in selected cases. Osteotomy was not applicable for primary treatment of this type of fracture. (H.H.D.)

30322 MYOCARDIAL HYPOXIA IN ACUTE AND CHRONIC RADIATION EFFECTS. N. A. Kurshakov and P. M. Kireev. Kardiologiya, 3: No. 2, 3-9(Mar.-Apr. 1963).

Changes occurring in the heart and resulting from the effect of ionizing radiation are based on complex pathogenic mechanisms brought about by neurotrophic processes in the organism, hypoxia, metabolic changes in cardiac tissues, infectious-toxic factors, and disruptions in tissue permeability. The same disruptions occur in the vascular system. (OTS)

30323 THE EFFECT OF GAMMA-RAYS OF Co^{60} ON SMALLPOX VACCINE CONTAMINATING MICROORGANISMS. E. F. Kalenina and A. Z. Abidov. Med. Zh. Uzbekistana, No. 2, 52-4(Feb. 1963).

Liquid smallpox vaccine inactivated by gamma irradiation proved to be fully adequate for studying the effects of gamma irradiation on the viability of microorganism artificially added to it. The complete inactivation of Staphylococcus albus and Bacillus subtilis, which most frequently contaminate smallpox vaccine, occurs by gamma irradiation from Co^{60} ranging from 900,000 to 1.5-million r doses at 47 impulses/second magnitude. (OTS)

30324 CYTOCHEMICAL MEASUREMENT OF PROTEIN SULPHYDRYLS IN CELL LINES OF DIFFERENT RADIOSENSITIVITY. Olle Caspersson and László Révész (Karolinska Institutet Medical School, Stockholm). Nature, 199: 153-5(July 13, 1963).

Results are reported from microspectrographic measurements of the content of protein sulfhydryls in individual cells from closely related tumor cell lines of different radiosensitivity. The data indicate a distinct relation between the protein sulfhydryl level and the chromosome number or the average amount of desoxyribonucleic acid of the cell lines. It is postulated that an increased content of non-protein sulfhydryl per unit of protein sulfhydryls, as well as per unit of desoxyribonucleic acid, may result in an increased radiation protection of proteins and genetic material. (C.H.)

30325 EFFECT OF ULTRA-VIOLET LIGHT ON SKIN COLLAGEN. Eva Bottoms and Sam Shuster (St. John's Hospital for Diseases of the Skin, London). Nature, 199: 192-3(July 13, 1963).

The effect of ultraviolet radiation on collagen fractions of isolated mouse skin was studied. Results indicate that ultraviolet radiation precipitates an insoluble collagen from the saline and citrate soluble collagens. Possible applications in studies of ultraviolet induced aging of human skin are discussed. (C.H.)

30326 INFLUENCE OF TEMPERATURE AND MEDIUM ON THE X-RAY SENSITIVITIES OF LEUKAEMIA CELLS IN VITRO. J. Z. Beer, J. T. Lett, and P. Alexander (Royal Cancer Hospital, London). Nature, 199: 193-4(July 13, 1963).

Results of experiments using x irradiated mouse leukemia cells in culture indicate that the mechanism of increasing survival by transfer from simple to complete medium is different from that obtained by lowering the post-radiation temperature. (C.H.)

30327 EFFECT OF UNSATURATED HIGH FATTY ACID FRACTION EXTRACTED FROM X-RAY IRRADIATED RABBIT LIVER (OX) ON THE MITOCHONDRIAL SWELLING OF NORMAL RAT LIVER. Hiroyuki Urakami (Okayama Univ., Japan). Okayama Igakkai Zasshi, 74: 307-12(Mar. 1962). (In Japanese)

The effects of a high unsaturated fatty acid fraction, extracted from x irradiated rabbit liver, on rat liver mitochondrial swelling was studied. Strong swelling action was demonstrated at concentrations above 0.001% in 0.15 KCl solution. Swelling action on mitochondria was reduced by sucrose but not changed by sodium succinate. Serum albumin and ATP inhibited completely the mitochondrial swelling. The incorporation of P^{32} into phosphates of swollen mitochondria was almost completely inhibited by this fatty acid fraction. (C.H.)

30328 THE INFLUENCE OF A SINGLE EXPOSURE TO X RAYS UPON THE DEVELOPMENT OF OVARIES IN CHICK-EMBRYOS AND CHICKS. A. V. Denisevskii. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 64-72 (1962).

Chick embryos and chicks were exposed to x rays (200 and 900 r, at a rate of 52.2 r/min). 59 chick embryos were exposed on the 4th–5th, 9th, and 14th day of incubation, and

92 chicks on the 6th and 11th days after hatching. The number and size of undamaged follicles was estimated on the basis of 25 sections taken from different places in each ovary, the average size of which was calculated separately for each series of experiments. Sections from animals of similar age not exposed to radiation served as controls. In 19-day old embryos which had been exposed on the 4th–5th day of incubation, the differentiation of the cortical layer was delayed. Slight degenerative changes, however, were repaired before the end of incubation. The changes were less marked in animals exposed on the 9th day of incubation. In embryos exposed on the 14th day of incubation, at a time when the germinal layer should begin to develop, it was severely affected. These changes were not repaired by the end of the egg incubation period. In chicks exposed on the 11th day, the oocytes were mostly affected, and after a dose of 900 r only 2 to 3 undamaged oocytes were found in one section. This number of undamaged oocytes was greater after exposure to 600 r and later regeneration could be observed. If the trunk of the chick was shielded and only the head exposed, the formation of follicles was more impaired than after irradiation of the trunk only. These latter experiments were carried out on the 6th and 11th day after hatching. Only in the case of the 11th day irradiation of the trunk was regeneration delayed. (OTS)

30329 THE DIRECT AND INDIRECT INFLUENCE OF X RAYS UPON THE SPERMATOGENESIS OF MICE. A. V. Denisevskii and A. V. Misyuk. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 73-80(1962).

Two groups of male mice were exposed to x rays, shielding in one group the head, and in the other the trunk, in order to establish whether an indirect influence of radiation on spermatogenesis could be observed in addition to its direct influence. Earlier reports concerning this problem have been of a contradictory nature. Some of the mice were exposed to a total single dose of 400 r from a distance of 10 cm at a rate of 34 r/min. Another group of mice were exposed to multiple-dose radiation continued for 1 month, at intervals of 7 days, up to a total dose of 200 r. 35 mice were used for the experiment and 22 mice served as controls. Radiation decreased the weight of the testes and the number of tubules containing spermatogonia were decreased. There were even more marked differences in the relative proportions of various cell types within the tubules. The changes were of similar nature, independent of whether the head or the trunk had been shielded against radiation. However, the changes were more marked in animals whose trunks were exposed. The influence of radiation upon the head are explained by changes induced in the central nervous system and in the pituitary gland. (OTS)

30330 THE INFLUENCE OF X RAYS UPON THE TRANSFORMATION OF STORAGE SUBSTANCES, TISSUE RESPIRATION, AND THE ACTIVITY OF OXIDATIVE ENZYMES OF SPROUTING PLANT SEEDS. S. O. Grebinskii, N. D. Iovleva, and I. V. Popovich. Probl. Lab. Radiodiol., L'vovsk. Gos. Univ., No. 1, 84-9(1962).

In an earlier paper, it was shown that high doses of radiation suppress the growth, the respiration rate, and the water adsorption of plant seeds. In the present paper, the underlying changes in the metabolism of seeds are investigated. Maize seeds, peas, sunflower seeds, and wheat grains were used for the experiment. The seeds were moistened and, when sprouting, were exposed to radiation at a rate of 15 r/min. After exposure, the seeds were grown in tap water at 25°C in the dark. The dehydrogenase activity and the respiration rate were estimated in a Warburg apparatus. The dehydrogenase activity was estimated in sections through the cotyledons of 1 μ thickness by the method of Markh and Fel'dman (Biokhimiya, v. 22, no. 6, 1957). The oxidase activity was measured by the method of Povolotskaya (Biokhimiya, v. 20, 1956) in buffered eluates. The results showed that small doses of radiation (500 r) increased the respiration together with the activity of the glucodehydrogenase and also to a lesser extent the isocitric acid dehydrogenase. Larger doses (10,000 r) suppressed primarily the activity of isocitric acid dehydrogenase and–to a lesser degree–of glucodehydrogenase. All doses between 500 and 25,000 r suppressed the activity of polyphenoloxidases and particularly of ascorbin-oxidase, but the peroxidase activity remained unchanged. Large doses inhibit the hydrolysis of storage substances such as protein and starch. In sunflower seeds, however, the hydrolysis of fat became more intensive under these circumstances. (OTS)

30331 THE INFLUENCE OF X RAYS UPON THE GROWTH AND YIELD OF ROOT CROPS. S. O. Grebinskii, L. I. Gadzevich, and I. I. Bodnar. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 90-7(1962).

Earlier studies had shown that treatment of sugar beets with radioactive isotopes stimulates the growth of the crop. A study was made of the effect of x rays. It was assumed that the expected influence would be more marked if sprouting seedlings were exposed rather than the inactive dry seeds. The seeds were moistened and when they had begun to sprout they were exposed to x rays from a distance of 2 m at a rate of 1000 r/min. The mature roots were weighed and compared with the weight of nonirradiated roots which served as the control. Exposure of sprouting seedlings to doses between 500 and 1000 r was found to lead to a significant increase in the yield of sugar beets, carrots, and marrows. Irradiation of dry seeds, conversely, decreased the yield and the average weight of the roots. After exposure to radiation, the roots had a somewhat higher proportion of parenchymatous tissue which led to a slight decrease in the sugar content. (OTS)

30332 THE INFLUENCE AND THE AFTER-EFFECT CAUSED BY X RAYS UPON CLOVER SEEDS IN THE FIRST HYBRID GENERATION. A. S. Palamarchuk. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 98-102(1962).

Earlier studies had shown that exposure of clover seeds to x rays (250 to 1000 r) stimulated the growth of the plants. However, the after-effects of this treatment upon the first hybrid generation have so far not been investigated. In the present work, clover seeds were exposed to x rays from a distance of 20 cm at a rate of 1000 r/min. This treatment was repeated 2 to 3 times and the seeds were then implanted into the soil together with nonirradiated seeds. After fertilizing blossoms by the dusting method, a new generation of seeds was obtained which was again sown into the soil. A dose of 1500 to 15,000 r usually suppressed growth of the plants and the yield lagged behind that of the control plants. The first hybrid generation gave, however, a higher yield than control plants of the same generation. In both the irradiated plants and in the first hybrid generation, the protein content was found to be increased. The first generation of hybrids reacted more strongly than the controls to changes in the quality of the soil, e.g., transfer of the first hybrid generation in peat or vice versa. Hybrids grown from seeds collected in the first year gave a higher yield than hybrids from the seeds of the same plants collected in the second year of their life. (OTS)

30333 RADIATION RECOVERY ENHANCED THROUGH INHIBITORS OF PROTEIN SYNTHESIS AND AMINO ACIDS.

Alvin V. Beatty and Jeanne W. Beatty (Emory Univ., Atlanta). Proc. Natl. Acad. Sci. U. S., 49: 434-9(Apr. 1963). Tradescantia inflorescences which were preirradiatively treated for 1½ hr in protein inhibitors, dihydrostreptomycin, puromycin, or chloramphenicol, and irradiated in helium, gave lower chromosomal aberration yields than did the chemically untreated controls. Thus, it was indicated that in these experiments, protein synthesis was not necessary for chromosome rejoining and that material treated with these antibiotics showed more recovery from radiation damage than the controls. The recovery is thought to be due to the presence of additional ATP brought about by the inhibition of protein synthesis and through the addition of amino acids in the pool. The amino acids could provide additional ATP through inhibitory feedback mechanisms and the catabolism of amino acids. The exogenous use of citrulline, histidine, proline, glycine, phenylalanine, cysteine, isoleucine, alanine, threonine, and serine reduced the aberration yield to a value approximating that obtained with the antibiotics. (auth)

30334 PRELIMINARY RESEARCH ON THE BEHAVIOR OF SOME PHYSIOLOGICAL GROUPS OF MICROORGANISMS IN SOIL IRRADIATED WITH COBALT-60. Angelo Rambelli (CNEN, Rome). Pubbl. Centro Sper. Agr. Forest., 6: 119-29(1962). (RT/BIO(63)13). (In Italian)

The microflora of soils irradiated with cobalt-60 was studied quantitatively. A general decrease in the number of microbes of the different physiological groups was found to be caused by irradiation, with successive slow return to normal conditions. Excluding the influence of gamma radiations, the soils investigated were characterized by irregular microbiological activities, with increase of certain phenomena as nitrogen fixation, ammonifying capacity, and cellulose dissolving capacity, and abnormal low intensity of others, as nitrification and denitrification. (auth)

30335 INFLUENCE OF THE WHOLE-BODY EXPOSURE TO X-RADIATION ON THE RENEWAL PROCESS OF THE CORNEAL EPITHELIUM. V. M. Mastryukova and A. D. Strzhizhovskii. Radiobiologiya, 3: 3-7(1963). (In Russian)

In order to clarify the effect of radiation injury on the mitotic activity changes, male white mice were exposed to doses of 100, 400, and 700 r of whole-body x radiation, at a dose rate of 20 r/min. The exposed and the control animals were killed 1, 3, 5, or 7 days after the exposure; as nearly all the animals died by the seventh day, no reliable data are available for this period. Cornea preparations were used for determining the mitosia and chromosome abberations. Analysis of the phase distribution of the mitosia served as an indicator of the radiation effects because it affects the time relations between the individual phases of the mitosis. During the first few days after exposure when the mitotic activity is greatly depressed, a definite lowering of the activity was observed. Its subsequent increase, in the case of exposure to doses of 100 and 400 r, occurs in parallel with the regeneration of the mitotic activity; after exposure to 700 r, it passes through a maximum between the first and third day after irradiation. This indicates that in that case, as in the case of the corneal epitheleum of unirradiated animals, the main cause of the cell reaction is due to the repeated replacement by cells formed during the cell fission. The divergent results obtained in the case of exposure to 700 r are probably due to the destruction of the cell by the radiation. (TTT)

30336 DEPENDENCE OF THE RADIATION SENSITIVITY OF E. COLI ON THE CULTURE METHOD AND ENVIRONMENTAL CONDITIONS AT THE TIME OF IRRADIATION BY X AND α-RAYS. Ya. L. Shekhtman, G. V. Filippova, and G. B. Radzievskii (Inst. of Biological Physics, Moscow). Radiobiologiya, 3: 34-8(1963). (In Russian)

It was observed earlier that E. coli cultures in glucose possess different properties than the bacillus in its usual medium. The relative biological effectiveness of these 2 types was investigated by exposing the 2 cultures to α-radiation of Po^{210} and to x radiation of various spectral composition, in an attempt to study the effect, if any, on the radiation sensitivity of the medium in which the irradiation was carried out. In the glucose type culture the dose curve obtained was S-shaped while the ordinary culture had an exponential shape. The S-shaped curve was also observed in the case of exposure to α-radiation. The radiation sensitivity of the glucose type culture was found to be lower by a factor of 4.5 for x radiation and a factor of 3 for α radiation than that of the ordinary culture. The relative biological effectiveness of the α radiation with respect to the 200-kev x radiation was 0.66 for the ordinary and 1.0 for the glucose culture. If intracellular toxic products play an important role in the primary biological activity of the radiation, then the S-shape of the curve and the decreased radiation sensitivity of the cultures may be attributed to the presence of antitoxic materials in the cells. (TTT)

30337 SOME DATA ON THE TOXEMIA OF IRRADIATED ANIMALS OBTAINED BY THE PERFUSION METHOD. Yu. D. Balika and G. M. L'vitsyna. Radiobiologiya, 3: 59-62(1963). (In Russian)

The perfusion of the organs of irradiated animals with the blood of healthy, unirradiated specimens was used for studying toxemia occurring in radiation sickness. From previous investigations it was concluded that the transmission of the toxic effect may be due to the outflow of the cellular elements of the blood and the bone marrow from the tissue of the irradiated organism into the recipient dog, or to the inflow of humoral materials. In order to clarify the toxic effect, perfusions were investigated by washing out cell components from the tissues of the donor animals, looking for antibodies. Instead of blood, an isotonic physiological solution was used at 38 to 40°C, passing it by gravity flow through the extremities of the dogs, exposed to 800 r at a rate of 17 r/min. No increase in the number of the morphologically recorded cells of the blood and the bone marrow was noted in the perfusates of the irradiated animals, and therefore the toxemia cannot be attributed to materials washed out from the tissue. Incomplete antibodies are not considered to play an important role in the transmission of toxic effects from the irradiated to the unirradiated animals: the leukocyte type autoantibodies represent one of the factors of the toxemia in the irradiated organisms. (TTT)

30338 THE ROLE OF RADIATION-INDUCED HUMORAL FACTORS ON THE REFLEXES OF THE INTESTINAL CHEMORECEPTORS. N. A. Lapshin (Kirov Military Medical Academy, Leningrad). Radiobiologiya, 3: 63-6(1963). (In Russian)

Humoral factors due to radiation injury are very important in the pathogenesis of the radiation syndrome. For this reason, tests were carried out for the determination of the effect of liquids formed by the perfusion of a section of the small intestine of irradiated animals on the reflexes of the cardiovascular system and the respiration of the chemoreceptors in the small intestine of unirradiated animals. The chemoreceptors of the small intestine of unirradiated cats were exposed to an irritating liquid, prepared by the

perfusion of the small intestine of an animal exposed to a radiation of 600 r. Changes in the blood pressure in the carotide, the heart activity and respiration served as criteria for judging the effectiveness of the humoral factors. The results showed that the as yet unidentified, biologically active materials formed in the intestinal tissue after irradiation induces an increase of the blood pressure, the rhythm of the heart beat, and the frequency of the respiration and causes a movement of the animal. The active material starts the reflex reaction and only at a later time is its general effect noticeable. (TTT)

30339 REACTIVE, POST-TRAUMATIC CHANGES IN THE MUSCLE TISSUE AFTER LOCAL X-IRRADIATION OF THE THYROID GLAND. T. N. Tuzhilkova (Chelyabinsk Medical Inst., USSR). Radiobiologiya, 3: 67-70(1963). (In Russian)

In view of the changes induced by ionizing radiation in the functional activity of the thyroid tissue that regulates the basal metabolism of the organism, it was attempted to determine the reparative regeneration of the skeletal muscles by the local irradiation of this gland. Male adult rats were used for the tests that involved the study of the traumatic regeneration of the muscle after a local irradiation of the thyroid by 1000 r of x radiation at time periods of 5 and 30 days after the exposure, determining the response to a cutting with a razor blade. It was found that the irradiation causes dystrophic changes, lowering the activity of the gland. The changes continue to increase from the 3rd day on; during the period from the 7th to the 10th day, at the height of the radiation sickness the formation of colloids and their introduction into the blood is considerably reduced. This is followed by a period of regeneration; after 30 days the gland operates nearly normal, although some radiation effects persist. The condition of the regenerative process varies with the time period after the irradiation. (TTT)

30340 COURSE OF THE CORASOLUM-INDUCED SEIZURES IN RATS AT VARIOUS PERIODS AFTER EXPOSURE TO IONIZING RADIATION. T. M. Kucherenko and N. A. Rokotova (Pavlov Inst. of Physiology, Leningrad). Radiobiologiya, 3: 71-5(1963). (In Russian)

It was attempted to clarify the behavior of the brain of the rat during the early period after irradiation. An excitation method involving pharmacologically induced seizures was used for the tests; seizures represent an excellent tool for studying the interaction between defense mechanisms and injury factors because they interfere with the equilibrium. Male white rats were exposed to whole-body x radiation of 750 r, carrying out the tests 1, 2, 4, 6, 9, 12, 18, 24, 36, 48, and 72 hours after the irradiation. Each group contained animals injected with 60 or 100 mg/kg of corasolum, and control specimens that were injected but not irradiated. It was found that during the first 4 hours after exposure, the seizure reaction following the injection of corasolum was accelerated, resulting in higher intensity and increased mortality. The difference between irradiated and unirradiated animals tended to decrease during the 6 to 8 hours after exposure but after 24 hours an accelerated reaction was noted again. During the period ranging from 36 to 72 hours, a greater difference in the reaction was noted between the two doses: the 60 mg/kg body weight dose resulted in a decrease of the differential behavior of irradiated and unirradiated specimens while the 100 mg/kg dose caused a general weakening of the reaction. (TTT)

30341 CHANGES IN THE ANTERIOR HYPOPHYSIS IN IRRADIATED FROGS. L. A. Kashchenko (Central Scientific Research Inst. of Medical Radiology, Leningrad). Radiobiologiya, 3: 76-80(1963). (In Russian)

The physiological aspects of the reaction to irradiation of the anterior hypophysis of the frog was studied, taking advantage of the fact that small changes in the gonadotrophic activity of the anterior hypophysis may be easily followed by noting the morphological and functional shifts in the reproductive organs. Male and female specimens of Rana temporaria were used during the early spring when their reproductive system is highly sensitive toward the gonadotrophic hormone. One group was exposed to whole-body radiation while the second group was irradiated in the gonad area only, to a total dose of 10 kr. Reaction to the radiation involved functional excitation, consisting in the ejection of hormones from the gland; radiation injury, leading to necrotic decay and regeneration of the glandular excretion system, primarily at the expense of the intact cells. It was noted, however, that these stages do not necessarily follow each other in that order. (TTT)

30342 AUTORADIOGRAPHIC INVESTIGATIONS WITH H^3-THYMIDINE FROM THE SYNTHESIS OF DESOXYRIBONUCLEIC ACID IN CELL COMPONENTS OF WHITE RATS AFTER WHOLE-BODY IRRADIATION BY X-RAYS. N. D. Gracheva (Central Scientific Research Inst. of Medical Radiology and Inst. of Cytology, Leningrad). Radiobiologiya, 3: 81-7(1963). (In Russian)

It was found previously that exposure to ionizing radiation depresses the participation of the cell not only in the mitosis but also in the DNA synthesis, with a subsequent increase of the proliferation during the regeneration period. In order to further clarify this problem, a study was carried out on the possibility of synthetizing DNA in the cell components of the nervous system, examining the effect of ionizing radiation on this process. H^3-thymidine, a specific precursor of DNA was used as the radioactive tracer material. Female white rats were exposed to 600 or 770 r of whole-body radiation at a rate of 49.8 r/minute. The tracer was injected subcutaneously at periods ranging from 1 to 240 hours after exposure, at a dose of 0.5 μc/g body weight, killing the animals 4, 24, or 48 hours after the injection. Unirradiated animals served as controls. The brain and the spinal cord and other parts of the body were subjected to autoradiography, checking the tritiated nuclei and the mitosia. This was allowed to follow the movement of the neuroblasts to the skin where they continue to differentiate and lose their ability to undergo fission. However, autoradiography did not reveal any synthesis of DNA. The injury phase was followed by a recovery phase. (TTT)

30343 DEVELOPMENTAL ANOMALIES AND MALFORMATIONS IN THE CENTRAL NERVOUS SYSTEM OF THE OFFSPRING OF γ-IRRADIATED ANIMALS. A. A. Osipovskii, Yu. I. Afanas'ev, A. I. Pauper, and Yu. S. Sukhanov (First Medical Inst., Moscow). Radiobiologiya, 3: 88-92(1963). (In Russian)

Study of the developmental malformations of mammals is very important for the understanding of human malformations caused by the after effects of radiation injury. The problem was investigated by exposing guinea pigs in puberty to 225 and 400 r of γ-radiation from a Co^{60} source at a rate of 17 r/minute. All the animals exhibited the typical clinical picture of radiation injury. The sterility noted with rats 1 to 3 months after irradiation, was not observed in guinea pigs. The exposure caused changes in the central nervous system of the offspring, accompanied by eye injuries. Occasionally, malformations of the teeth, the skeleton, and the soft tissues were also noted. The anomalies observed during the development, such as hy-

drocephalism, degeneration of the skin, and eye injuries are attributed to mutations in the central nervous system. (TTT)

30344 IMMUNOCHEMICAL ANALYSIS OF THE LIVER PROTEINS DURING RADIATION SICKNESS. O. Ya. Tereshchenko, E. M. Belyaeva, and L. F. Mikhailova. Radiobiologiya, 3: 93-8(1963). (In Russian)

O. Ouchterlony's method was used in the determination of the antigenic properties of liver proteins during radiation sickness. All the soluble protein extracts of the liver of the rat and the proteins of the individual micromorphological components of the cytoplasm after an exposure to 650 r of ionizing radiation at a dose rate of 122 r/min, were investigated. Rabbit sera were used for establishing individual differences in the antigen content. The rabbits were immunized with liver protein extracts of healthy and irradiated rats. The most characteristic radiation-induced changes in the antigen spectrum consisted in the weakening of one group of antigen accompanied with the enhancement of other groups. The proteins exhibiting the greatest amount of changes presented a great mobility in the agar gel. (TTT)

30345 RELATIVITY OF THE RADIATION-INDUCED IMMUNOLOGICAL TOLERANCE. R. V. Petrov and V. F. Sosova. Radiobiologiya, 3: 99-103(1963). (In Russian)

Acclimatization of foreign tissues and the depression of the absolute immunological reactivity are very important for developing immunological tolerance in irradiated organisms. Recent data refuted the widely held notion that exposure to ionizing radiation causes a total depression of the antibody formation. A review of the pertinent literature concerning the effect of radiation on the immunological activity of animals leads to the conclusion that the tolerance is relative. In order to create radiation chimaera, it appears to be sufficient to prolong the inductive phase of the antibody formation; this results in the adaptation of the recipient to the transplanted cells. On the basis of preliminary calculations it is estimated that this adaptation period continues for 10 to 14 days. (22 references.) (TTT)

30346 THE PROTECTIVE ACTION AGAINST X-RADIATION OF THE ADAPTATION TO HYPOXIA, IN COMBINATION WITH ACUTE HYPOXIA. G. A. Vasil'ev and V. A. Belyaev. Radiobiologiya, 3: 117-20(1963). (In Russian)

An attempt was made to clarify the protective effect of the acclimatization to hypoxia on the resistance of the animals, subsequently exposed to a whole-body irradiation, in combination with acute hypoxia by determining the O consumption under various conditions of irradiation of acclimatized and non-acclimatized animals. The first group of male white mice adapted to hypoxia was irradiated under normal O content, the second, group under conditions of hypoxia, at an O content of 10 to 12%. A total dose of 600 r was used at a dose rate of 40 r/minute. The results indicated that the protective action of the adaptation to hypoxia is greatly enhanced by using it in connection with acute hypoxia: the O consumption was increased under the influence of the adaptation; when irradiated, both the adapted and the normal mice exhibited higher O consumption rates. Under conditions of hypoxia, the O consumption was reduced for both the adapted mice and the control animals. The increase of the O consumption under the effect of irradiation takes place unevenly, exhibiting characteristic peaks. (TTT)

30347 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF IRRADIATED AND MONOMER-TREATED WHEAT GERMS. Yu. P. Kozlov and G. B. Sergeev (Moscow State Univ.). Radiobiologiya, 3: 130-1(1963). (In Russian)

The radiation-induced formation of free radicals presents a great interest for radiation protection. The electron paramagnetic resonance method was used for investigating the changes in wheat germs after exposure to γ radiation, and after treatment with vinyl pyrrolidone monomer. The vacuum-dried germs were irradiated in the presence of O at a total dose of $4 \cdot 10^4$ r and treated either with water only, or with a 5% solution of vinyl pyrrolidone. EPR spectra were taken for determining the presence of the free radical of diphenyl picryl hydrazyl. Irradiated but untreated germs exhibited an asymmetric singlet signal with a half width of 10 oersted and a q factor of 2.004. The free electron concentration was found to be 2.75×10^{14}, being slowly reduced with time, and with increasing temperature. The character of the spectrum did not change when the dose was increased to 3×10^6 r. Post-irradiation treatment with vinyl pyrrolidone reduced the signal and resulted in the elimination of free radicals from the system. Treatment with water resulted only in a slight reduction of the number of the free electrons. (TTT)

30348 GROWTH AND DEVELOPMENT OF VICIA FABA L. UNDER CONDITIONS INVOLVING INCREASED URANIUM AND RADIUM CONTENT. P. P. Vavilov, I. N. Verkhovskaya, R. P. Kodaneva, and O. N. Popova (Komi Radiobiological Lab., Academy of Sciences, Syktyvkar, USSR). Radiobiologiya, 3: 132-8(1963). (In Russian)

In order to differentiate between chemical toxicity and the radiation from Ra and U, a series of tests was started in 1961, using the black Russian variety of the very radiosensitive Vicia faba, growing in soils containing 4×10^{-1}% U and 1.06×10^{-1}% Ra. The plants were thus exposed to a constant, weak β, γ radiation source at a dose rate of 0.0001 r/hr. The results showed that the presence of the radioactive elements exerts a harmful effect on the growth and the development of the plant: growth of the stem and formation of new leaves were inhibited, the general biological productivity of the plant was reduced and aging processes were accelerated. Most of this effect is ascribed to the ionizing radiation. (TTT)

30349 THE EFFECT OF EXPOSURE TO THE γ-RADIATION FROM A COBALT-60 SOURCE OF TUBERS BEFORE SETTING OUT ON THE YIELD AND THE VITAMIN CONTENT OF POTATO. N. M. Berezina, G. I. Shchibrya, V. V. Drozhzhina, R. R. Riza-Zade, and A. D. Tarasova (Inst. of Biological Physics, Moscow). Radiobiologiya, 3: 139-42(1963). (In Russian)

The previously reported observation that the preliminary irradiation of tubers increases the vitamin C content and the yield of potato is very important because the potato is the chief source of vitamin C for a large portion of the population. This was further investigated by exposing Berlichingen-type potatoes, stored at 3 to 5°C, to 100, 250, 500, and 2000 r at a dose rate of 75 r/min; the number of sprouts, the density of growth, blooms, and the vitamin C content were determined after the irradiation. The results indicated that exposure to radiation increased the yield by 17 to 55%; the exposure range from 500 to 2000 caused the largest increase. The vitamin C content was also higher after exposure to 500 to 2000 r. Best results were obtained 2 weeks before harvesting; during storage the vitamin content decreased. (TTT)

30350 THE EFFECT OF RADIATION ON THE LIPOPROTEIN CONTENT OF THE LIVER MITOCHONDRIA

AND THE PHOSPHATIDES IN THE RABBIT SERA AND THE PROTECTIVE INFLUENCE OF VITAMIN B_6 ON THIS PROCESS. A. F. Mosin (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 3: 143-6(1963). (In Russian)

The effect of vitamin B_6 on the lipoprotein content in the various cell components was investigated, comparing the results with the phosphatide content in the blood sera of the irradiated animals. The tests were carried out on the liver mitochondria and blood sera of rabbits. Vitamin B_6 was administered at the rate of 3 mg pyridoxine base per kg weight for eight days once daily to test animals that were subsequently exposed to 1000 r of x radiation at a rate of 18 r/min, killing the animals 12 hours after the irradiation. It was found that after irradiation alone the amount of lipoproteins in the liver mitochondria was lowered to 25% while the lipid phosphorous content of the serum was increased. Administration of vitamin B_6 in most cases prevented completely or reduced the subsequent changes in both the lipoprotein content of the liver mitochondria and the lipid P of the blood serum. The amount of lipid P in the liver mitochondria of the irradiated and unirradiated rabbits was identical. (TTT)

30351 THE BIOLOGICAL ACTION OF FREE RADICALS FORMED BY THE ANODIC OXIDATION OF TYROSINE. N. A. Klipson and T. G. Mamedov (Moscow State Univ.). Radiobiologiya, 3: 146-7(1963). (In Russian)

The biological action of the free radical formed during the electrolysis of tyrosine (α-amino β-oxyphenyl propionic acid) on the haploid and diploid strains of yeast cells was investigated. A standard yeast suspension was prepared in a saturated solution of tyrosine in 5% sodium acetate, using the latter material primarily to increase the electrical conductivity of the system. The solution was electrolyzed at 4.5 v, using Pt electrodes, for various time periods. As the criterion of the action of the free radicals, the survival rate of the yeast cells was evaluated on the basis of the microcolonies, comparing the results with the survival rate of yeast cells exposed to 1.2 kr/min of radiation. The results showed that the free radicals exert a strong harmful effect; after 45 minutes of electrolysis, all the cells were killed. At shorter periods, the haploid and diploid cells exhibited a differential behavior, depending on their radiosensitivity. Subsequent tests showed that vinyl pyrrolidone exerts a protective action against the tyrosine radicals. Regeneration of the cells exposed to the action of these radicals followed the pattern exhibited by cells exposed to γ radiation. In view of the similarity of the action of tyrosine radicals to radiobiological effects, the anodic oxidation technique may be a convenient method for studying radiation injury and radiation protection. (TTT)

30352 CHANGES IN THE ELECTRON SPECTRA OF THE IN-VIVO AND IN-VITRO IRRADIATED OXYHEMOGLOBIN SOLUTIONS. I. V. Vysochina (Inst. of Biological Physics, Moscow). Radiobiologiya, 3: 147-9(1963). (In Russian)

In order to further study the irreversible damages in the respiratory function of the blood by irradiating the animals, the electron spectra of oxyhemoglobin from the blood of irradiated rabbits and from blood, irradiated in vitro, were examined. The rabbits were exposed to a whole-body radiation of 900 to 1300 r at a rate of 21 r/min, while for the in vitro study, a mixture of rabbit, rat, and human blood was exposed to 1, 5, 10, 20, and 30 kr, determining the visible and near-ultraviolet electron spectra of the oxyhemoglobin. It was found that immediately after irradiation, the oxyhemoglobin from the blood undergoes changes; shifts were noted in the spectral bands. The absorption is increased if the animal died within the first day after the irradiation, decreasing if it survived longer periods. Direct irradiation of the blood in vitro exhibited the same characteristics as the in vivo irradiated blood; exposure beyond 1000 r either did not affect the absorption intensity of the oxyhemoglobin or actually lowered it. It is assumed that the irradiation causes excitation of additional electron levels of the Fe, the N of the imidazol residue of the histamine of the globin portion of the molecule, rendering the addition of O to the oxyhemoglobin more difficult. (TTT)

30353 A STUDY OF THE RADIATION DAMAGE TO DNA DETERMINED BY THERMAL SEPARATION OF THE DNA STRANDS. 1. AN ANALYSIS OF LOCAL DAMAGE IN DNA CAUSED BY IONIZING RADIATION. N. I. Ryabchenko and P. I. Tseitlin (Inst. of Experimental Biology and Medical Radiobiology, Academy of Medical Sciences, Moscow). Radiobiologiya, 3: 153-8(1963). (In Russian)

The local damage in a DNA molecule caused by X-rays was analyzed by thermal separation of the DNA strands with subsequent determination of the single-stranded DNA molecular weight by viscosity measurements. Native DNA was irradiated in 0.01M NaCl solution with various doses of x rays, and after irradiation, the DNA strands were separated by heating the sample at 89°C for a period of 15 minutes with subsequent rapid cooling. The characteristic viscosity η was then measured. A plot of log η versus log R (the irradiation dose) showed that the strands obtained as a result of the thermal separation of irradiated DNA are single-stranded chains, that is, degradation of native DNA by x rays follows the kinetics characteristic of a single-stranded polymer. The single-stranded DNA showed a greater decrease in viscosity than the double-stranded DNA on diffusing the polymer from a 0.01M NaCl into a 0.2M NaCl solution. The temperature increase of the viscosity at 70°C as compared to the viscosity of 25°C in 0.2M NaCl was greater for the single-stranded DNA than for the double-stranded DNA. The number of cleavages in the DNA chain as a function of dose was determined experimentally and calculated theoretically. The experimental and theoretical values were in good agreement. The number of cleavages at a given dose depends on the presence of protective agents such as EDTA. (TTT)

30354 OXIDATIVE PHOSPHORYLATION AND THE OPTICAL DENSITY OF MITOCHONDRIA IN THE NORMAL AND REGENERATING LIVER OF RATS SUBJECTED TO A WHOLE BODY DOSE OF X-RAYS. Ven-mei Shen (Inst. of Experimental Medicine, Academy of Medical Sciences, Leningrad). Radiobiologiya, 3: 159-67(1963). (In Russian)

It is well known that tissue characterized by a high degree of mitotic activity is generally more sensitive to radiation than is the same tissue in a state of relative rest. About 2/3 of the liver by weight was extirpated from male rats subjected to a 1000 r dose of x-rays. The mitochondria were isolated from the liver by centrifugation at 10,000 g for 15 minutes. The oxygen requirement, determined on a Warburg manometer, and the phosphate release on incubation with yeast hexokinase were expressed as a ratio of P:O (ratio of atoms). The ratio served as a measure of oxidative phosphorylation (OP) in the tissue. The level of oxidative phosphorylation in the mitochondria for rats 24 hours after irradiation was lower with a noticeable decrease in phosphate esterification than it was for normal intact rats. The experiments showed that whole body irradiation during the period of recuperation (48 hours or more after the partial hepatectomy) led to a sharper suppression of oxidative phosphorylation than in experiments where the

whole body dose of 1000 r was administered before the reoperative period (24 hours or less after the operation). It was found that the mitochondria, isolated 72 hours after the operation, in animals which had been irradiated 48 hours after the operation, showed a lower optical density in 0.125M KCl or in a phosphate buffer than did a suspension of mitochondria isolated from the same animals before recuperation and irradiation. Damage to the structure of the mitochondria was also evident from the fact that the swelled mitochondria did not contract as readily as did the mitochondria from the controls on adding ATP and $MgCl_2$ to the suspension. These data indicate that radiation administered during an active period of regeneration (72 hours after the operation) damages cell structure of mitochondria more than does radiation administered before period of active growth (24 hrs after the operation). (TTT)

30355 A STUDY OF THE NATURE OF THE EFFECTS OF X RAYS ON THE ACTIVITY OF TISSUE PROTEINASES. B. M. Graevskaya and R. N. Shchedrina (Inst. of Genetics, Academy of Sciences, Moscow). Radiobiologiya, 3: 168-73(1963). (In Russian)

Rats were given a whole-body x-ray dose of 600 r (series 1), a local dose of 600 r to the spleen with the rest of the body shielded with 3 mm lead (series 2), and a whole-body dose of 600 r with the spleen covered with 3 mm sheet lead (series 3). The mice were killed 5 minutes, 2, 24, 48, and 96 hours after the irradiation in order to determine the cell count in the spleen and liver, and to determine the proteolytic activity in the tissue by the rate of degradation on incubation in an acetate-phosphate buffer at a pH of 4.8 of a 1% casein solution. The build-up of tyrosine determined spectrophotometrically at a wavelength of 275 mμ was a measure of the proteolytic activity. The results show that the proteolytic activity of the spleen in whole-body irradiated animals is most pronounced 48 hours after the irradiation. Local irradiation of the spleen with the rest of the body shielded with lead does not result in an increase of proteolytic activity. There is a decrease in weight of the spleen during irradiation. The proteolytic activity of a liver extract after a whole-body irradiation reaches its maximum four days after the irradiation. The necrotic changes in the spleen are not related to its proteolytic activity. (TTT)

30356 THE EFFECT OF GAMMA IRRADIATION ON THE ACTIVITY OF TRIBUTYRINASE IN THE LIVER AND IN THE EPIDIDYMAL FATTY TISSUE OF THE RAT. M. A. Lomova. Radiobiologiya, 3: 174-6(1963). (In Russian)

Rats were given a dose of 800 r, and were killed 5 minutes, 2, 6, 24 hours, and 3 and 5 days after the irradiation. The ability of a tissue extract to degrade tributyrin in a buffered ammonium solution at a pH of 8.2 was used as a measure of the lipolytic activity of the tissue. The specific activity of the enzyme in the tissue was also obtained by determining the nitrogen content of the tissue by a micro-Kjeldahl analysis. The results show that the specific activity of tributyrinase in the liver increases by 33% two hours after the irradiation, falls to its normal level 6 hours after the irradiation, rises again 24 hours after the irradiation, and decreases to its normal value only on the 5th day after irradiation. The activity of the enzyme per 100 mg of tissue is a factor of 20 lower in the epididymal fatty tissue than in the liver, but the specific activity of the enzyme (activity per unit amount of nitrogen) is about the same for both tissues. Although the specific activity of tributyrinase did not change, the weight of the epididymis was 129 mg in the irradiated animal compared to 540 mg in the controls. Hence, other lipases in the epididymal tissue could have been affected by the irradiation. (TTT)

30357 THE EFFECT OF IONIZING RADIATION ON THE ACTIVITY OF PEROXIDASE IN CORN SEEDLINGS GROWN FROM IRRADIATED SEEDS. N. M. Berezina and V. A. Yazykova (Inst. of Biological Physics, Academy of Sciences, Moscow). Radiobiologiya, 3: 177-80(1963). (In Russian)

Corn seeds of the Sterling variety were given a stimulating dose of 500 r, and a lethal dose of 40,000 r in a Co^{60} irradiator. The peroxidase activity was determined separately in the corymb, kernel, and endosperm on the 2, 4, 6, 8, and 13th day of growth. The highest peroxidase activity was observed in the corymb with a somewhat smaller amount in the kernel, and very little peroxidase in the endosperm. A 500 r dose shows a 12 and 17% increase in peroxidase activity on the 2nd and 4th days of growth as compared to the activity of this enzyme in the kernels of the control seedlings. The peroxidase activity then gradually drops to a level which is 70 to 82% of the activity in the kernels of the control seedlings. On irradiating the corn seeds with a lethal dose of 40,000 r, the peroxidase activity showed decreases of 43 and 73% of the activities in the kernels of the controls on the 2nd and 4th days of growth, respectively. Then, the activity increased sharply to 167% on the 6th day, 211% on the 8th day, and 341% on the 13th day of growth, where the seedling finally died. (TTT)

30358 RADIATION AND CHANGES IN THE NUCLEI OF HUMAN CELLS DURING VARIOUS PHASES OF THE CELL CYCLE IN A TISSUE CULTURE. N. P. Dubinin and L. G. Dubinina (Inst. of Biological Physics, Academy of Sciences, Moscow). Radiobiologiya, 3: 181-90(1963). (In Russian)

The type of change of the cell nucleus as a function of the chromosome structure at various phases of the cell cycle, the difference in sensitivity for various chromosomal rearrangements during different phases, and the changes in time periods for various cell cycles are important factors in considering the effect of radiation on human cells. A suspension of human cells prepared from a two-month embryo was given an x-ray dose of 50 r. Cell samples were taken from 2 to 70 hours after the irradiation, and the chromosomal rearrangements were classified according to type (separate fragments, paired fragments, isochromatid bridges without fragments, bridges with a single fragment, bridges with two fragments and chromosomal, asymmetric translocations). The frequency of cell changes was very high (58.8% and 27.1%) at 2 to 4 hours after the irradiation. It fell to 11.7% at 6 to 14 hours, and was equal to 22.6% from 17 to 25 hours. It was 29.5% at 26 to 28 hours, 24.7% at 29 hours, and it fell from 13% to 8.7% at 30 to 70 hours after irradiation. The early prophase of mitosis (2 hours after radiation) shows the maximum radiosensitivity, and the post-synthetic phase which starts 17 hours after the irradiation and lasts 4 to 6 hours is the least radiosensitive. The type of rearrangement depends on the fusion or non-fusion of the sister fragments. Part of the rearrangements are chromosomal, and part are of both chromatid and chromosomal origin. (TTT)

30359 THE EFFECT OF NEUTRON IRRADIATION ON THE MITOTIC ACTIVITY OF THE CORNEAL EPITHELIUM. V. M. Mastryukova and A. D. Strzhizhovskii. Radiobiologiya, 3: 191-6(1963). (In Russian)

Mice were given whole-body neutron doses of 50, 100, and 200 rads (14% of the dose was γ-radiation) in a nuclear reactor. The mice were killed on the 1st, 3rd, 5th, and 7th

day after irradiation. The number of cells, the size distribution of the cells, the number of mitotic events per 10,000 cells, and the number of chromosomal aberrations (bridges, fragments) during anaphase were determined on stained preparations of the cornea. The average number of cells in the field of view of the microscope at a magnification of 7 × 2.5 × 60 was 203 cells on the average for the controls. The average mitotic index of the cornea was 7.70×10^{-3} for the controls. Among the observed mitoses, there are on the average 0.386 prophase, 0.234 metaphase, 0.216 anaphase and 0.164 telophase in the controls. The distribution of mitoses in the cornea of the irradiated mice is tabulated according to cell cycle (prophase, metaphase, anaphase, and telophase) for doses of 50, 100, and 200 rads at 1, 3, 5, and 7 days after irradiation. The mitotic activity and the number of cells decrease. A mathematical treatment is used to show that the genetic effect is greatest on the first day after irradiation. The relative biological effectiveness of fast neutrons is 4.6 according to the genetic effect, but is significantly less than 4.6 with respect to the decrease in mitotic activity. It is shown that cells with chromosomal aberrations die at a faster rate than do normal cells. (TTT)

30360 THE SELECTION OF A MODEL DESCRIBING THE RECOVERY OF VIABILITY OF YEAST CELLS DAMAGED BY GAMMA IRRADIATION. Yu. A. Buevich, E. M. Karabaev, and V. I. Korogodin (Moscow State Univ.). Radiobiologiya, 3: 197-203(1963). (In Russian)

The cell model assumes that chromosomal damage to the cell is eliminated abruptly, and the independent model assumes that the damage to the cell is gradually decreased. Diploid yeasts cells of Saccharomyces vini Megri-139-B were given Co^{60} γ-ray doses of 40.8, 81.6, 122.4, and 163.2 kr. The data show that the survival of the yeast cells increases with time. Furthermore, the number of cells which are deactivated after one or two generations decreases with time as compared to the number of cells deactivated after five or six generations. The post-radiation recovery of the yeast cells is best described by the independent model, that is, by a gradual recovery in viability. By taking into account the irreversible damage to the cell, an equation is derived that describes N_1 and N_2 as a function of time over the time interval $6 < t < 30$ hours. Here N_1 is the number of cells which are inactivated after one to two generations, and N_2 is the number which are inactivated after five to six generations. At higher dose rates, the equation is applicable only after 24 hours of post-radiation incubation (the initial survival of the irradiated cells increases by a factor greater than 30). (TTT)

30361 THE EFFECT OF BETA RADIATION ON THE BIOELECTRICAL ACTIVITY OF A SINGLE NERVE ENDING (CORPUSCLE OF VATER-PACHINI). O. B. Il'inskii and E. I. Komarov (Pavlov Inst. of Physiology and Inst. of Medical Radiology, Leningrad). Radiobiologiya, 3: 216-19(1963). (In Russian)

The Pachinian corpuscle from the mesentery of the cat was isolated by an operation, and was placed in a physiological solution of vaseline. The temperature of the corpuscle and of the nerve was maintained at 36 to 38°C. Special attention was given to maintaining a proper blood supply for the corpuscle. The potential of the nerve was taken off by way of an agar strand which was connected to a cathode repeater and an AC amplifier. The corpuscle was stimulated mechanically from the thrust of a glass rod attached to a piezoelectric crystal. Ordinarily, a threshold pulse which gave a response in 50% of the cases was used in order to determine an increase or decrease in excitability of the receptor. Irradiation of the receptor was carried out with a Sr^{90} β-applicator which gave a total dose of 930 rads over a period of 70 minutes. An isolated saphenous nerve (n. saphenus) was also irradiated. The threshold response decreased with increasing radiation. With a constant excitation, the response was 20% at the beginning of the experiments, 50% at a dose of 200 rad (15 minutes irradiation), and a response was evoked in 100% of the attempts with a dose of 810 rads (60 minute irradiation). Since irradiation of the saphenous nerve showed no increase in excitability with irradiation, it is concluded that irradiation has an effect on the membrane of the nerve ending, and not on the membrane of the nerve itself. (TTT)

30362 THE HIGHER NERVOUS ACTIVITY OF ADULT RATS WHICH HAD BEEN SUBJECTED TO A SINGLE, SMALL, PRENATAL DOSE OF IONIZING RADIATION. I. A. Piontkovskii and I. A. Kolomeitseva (Inst. of Higher Nervous Activity and Nerve Physiology, Academy of Sciences, Moscow). Radiobiologiya, 3: 220-3(1963). (In Russian)

White Wistar rats were given x-ray doses of 10 r and 25 r on the 18th day of the prenatal development. The rats grown from the litters were subjected to a positive, conditioned reflex to a tone of 400 cycles per second with a 10 decibel attenuation. After obtaining 10 correct positive responses in succession, the rats were subjected to a negative conditioned reflex towards a tone of 800 cycles per second with a 15 decibel attenuation. After five correct negative responses in succession, an attempt was made to obtain 10 correct positive responses in succession to a red bulb of six watts. The responses are typical for each group. After starvation for two days, the latent period of the response decreased in the controls and in the group given a dose of 10 r, but increased slightly in the group given a dose of 25 r. The double conditioned reflex was the most reliable of the tests. It was found that 63.2% of the controls, 12.5% of the rats given a 10 r dose, and none of the rats given a 25 r dose were able to adapt to the double, conditioned reflex within 30 experimental attempts. Both irradiated groups suffer a loss in mobility of higher nervous activity as compared to the control group. (TTT)

30363 THE EFFECT OF CHRONIC IRRADIATION OF THE HEAD WITH Co^{60} ON THE HIGHER NERVOUS ACTIVITY OF THE DOG. N. N. Livshits and E. S. Meizerov (Inst. of Biological Physics, Academy of Sciences, Moscow). Radiobiologiya, 3: 224-9(1963). (In Russian)

Three dogs, having a strongly uncompensated type of higher nervous activity (Pegas), a very inert type (Zhuk) and a weak type of nervous activity (Pushok), were given a total dose of 500 r of Co^{60} radiation over a period of four months. The daily dose of 4.5 to 5.5 r was administered six times per week. No external symptoms of radiation sickness were observed during the irradiation period, although a slight leucocytosis was observed in Pegas, and a decrease in the relative content of lymphocytes from 25 to 16% was observed in Pushok. The amount of conditioned salivary flow, the absence of a motor alimentary reflex and other disturbances were used as indices of the effect of chronic radiation on the higher nervous activity of the animal. All the animals showed disturbances in the higher nervous activity. Pegas and Pushok showed maximum shifts during the second and third months of the irradiation, and Zhuk on the second month of irradiation. The disturbances in Pushok and Pegas persisted for about three

months after the irradiation, but the higher nervous activity of Zhuk (highly stable type of nervous activity) returned to normal during the 3rd and 4th month of irradiation. No correlation between the disturbance in higher nervous activity and radiation dose could be obtained because of the activation of compensatory processes during the irradiation. (TTT)

30364 THE PREVENTION OF RADIATION DEPOLYMERIZATION OF DNA FROM RAT LIVER BY MEANS OF PROPYLGALLATE AND 5-METHOXYTRYPTAMINE. L. S. Isupova and V. S. Balabukha. Radiobiologiya, 3: 256-8(1963). (In Russian)

White rats were given an x-ray dose of 650 r. Propylgallate, which is a free radical inhibitor, and 5-methoxytryptamine, which prevents the oxidative deamination of a bio-substrate, were injected into the rats 15 minutes before the irradiation. The rats were killed 6, 24, and 72 hours after irradiation, and a preparation of DNA was isolated from the liver for viscosity measurements on a 0.2% aqueous solution of DNA. The results show that the injection of propylgallate prevents the radiation depolymerization of DNA for a period of 72 hours after the irradiation. The injection of 5-methoxytryptamine is less effective, since a drop in the viscosity of the DNA solution is observed 24 hours after the irradiation. (TTT)

30365 THE RELATIVE GENETIC EFFECTIVENESS OF 500 Mev PROTONS AND 180 kev X RAYS. E. D. Plotnikova and S. I. Strashnenko. Radiobiologiya, 3: 286-90(1963). (In Russian)

White male rats were subjected to a whole-body irradiation with 500 mev protons at doses of 55, 200, 360, 520, 780, and 1030 rads. The irradiated rats were bred to unirradiated females within three days after the irradiation, and the females were killed on the 14th to 16th day of pregnancy. The number of ova, implantation sites, and viable embryos were determined by autopsy. The number of embryonic deaths due to dominant lethals in the spermatozoids of the rats increased with increasing irradiation dose. One type of dominant lethal caused death of the embryo before implantation, and another after implantation. The number of surviving embryos can be expressed as a function of irradiation dose as follows: $f(D) = e^{-\eta D}$. Here, η is the probability for the occurrence of a dominant lethal in a single spermatozoid per 1 rad (the mutation rate), and was found experimentally to be equal to 1.0×10^{-3}. The mutation rate is 1.7×10^{-3} for x rays, and hence, the relative genetic effectiveness for 500 mev protons is 0.6. The LD_{50} value (average lethal dose) for rat embryos was found to be 383 ± 15 r for x rays, and 565 ± 21 rad for 500 mev protons. The relative genetic effectiveness of the protons is 0.7 in this case. (TTT)

30366 A CYTOLOGICAL ANALYSIS OF THE EFFECT OF HIGH-ENERGY PROTONS. 1. CELL DEGENERATION AND MITOTIC ACTIVITY OF BONE MARROW IN MICE SUBJECTED TO WHOLE-BODY IRRADIATION WITH 660 MEV PROTONS. N. L. Shmakova and S. P. Yarmonenko (Inst. of Industrial Hygiene and Prophylaxis, Academy of Medical Sciences, Moscow). Radiobiologiya, 3: 291-3 (1963). (In Russian)

White mice were subjected to 660 Mev proton doses of 800 and 1000 rads. The mice were killed at various times after the irradiation, and a total of 3000 to 5000 cells from the bone marrow were examined in order to determine the number of degenerate cells, and the mitotic activity of the cells. With a dose of 800 rads, the number of degenerate cells is 2% one hour after the irradiation, and reached a maximum of 5% three hours after the irradiation. The number of degenerate cells then decreases to a normal value two days after the irradiation. With a dose of 1000 rads, the number of damaged cells attains a maximum of 8.5% in three to five hours after the irradiation. No mitoses were observed for the first three hours after irradiation. The mitotic activity then began to rise, and attained a normal value after two days. A comparative experiment was run by giving the mice a Co^{60} dose of 800 rads. It was found that the number of degenerate cells from the Co^{60} irradiation is a factor of at least two greater than the number of degenerate cells observed by proton irradiation at a dose of 800 rads. The relative biological effectiveness of the protons is 0.3, when compared to the effectiveness of the γ rays. (TTT)

30367 THE EFFECT OF X-RAY IRRADIATION ON THE GROWTH, AND THE MICROSCOPIC AND S^{32}B-MICROSCOPIC STRUCTURE OF BONE SARCOMAS INDUCED BY RADIOACTIVE STRONTIUM. O. A. Khomutovskii (Bogomol'tsa Inst. of Physiology, Kiev). Radiobiologiya, 3: 294-9(1963). (In Russian)

Bone sarcomas were induced in rats by the intraperitoneal injection of two doses of Sr^{90} at monthly intervals using a dosage of 0.32 μC of Sr^{90} per gram of body weight. The sarcomas appeared in 15 out of 60 rats on the 170th to 200th day after injection of the Sr^{90}. Induced sarcomas were given a local x-ray dose of 9 kr and 18 kr. With an irradiation dose of 18 kr, growth of the sarcoma is retarded, and the parts of the tumor where formation of osteoid material occurs are almost completely destroyed. With a dose of 9 kr, the tumor continues to grow, and the destruction is less marked. Cancer cells from the irradiated sarcoma can be transplanted. However, in the transplanted tumor, the cells lose their ability to metastasize to other sites, to lyse osseous tissue, and to form osteoid material. Changes in the size and form of the mitochrondria and the shell nucleus of the cells were observed after x-ray irradiation of the bone sarcoma. (TTT)

30368 AN EXPERIMENTAL STUDY OF EARLY STRUCTURAL CHANGES OF AN IRRADIATED, INTERAURICULAR SEPTUM OF A FROG. (LIVE AND HISTOCHEMICAL OBSERVATIONS). L. A. Afrikanova. Radiobiologiya, 3: 300-10(1963). (In Russian)

The beating heart of a frog with its interauricular septum stretched was placed in a Lock-Lewis solution, and was given an x-ray dose of 19,700 r. An increase in the frequency and magnitude of the heart beat was observed as a direct effect of the irradiation, but no change in the optical properties of the neuroplasma and synapes could be detected by microscopic observation. Staining techniques were used to follow pathological changes in muscle fibers, connective tissue, and in nerve cells. Thus, staining with 0.01% methylene blue indicated that metachromatic material was being released from the cytoplasm into the surrounding medium from neurons and fatty cells. Histochemical tests with tetrazole showed changes in dehydrogenase activity, which can be ascribed to a breakdown in the permeability of the lipoprotein membrane structure of the mitochrondria in nerves and connective tissue. Staining by copper sulfide deposition indicated the radioinduced decrease in cholinesterase activity in various nerve structures, such as neurons and synaptic joints. The deposition of copper sulfide decreases with irradiation. These tests indicate that the permeability of cell and mitochondrial membranes is broken down by irradiation. (TTT)

30369 AN EXPRESS METHOD OF DETERMINING RADIOSTRONTIUM IN THE BODY OF MAN OR OF AN ANIMAL DURING ITS LIFETIME. V. A. Ivanov, M. S. Kulish, and E. I. Artsev. Radiobiologiya, 3: 321(1963). (In Russian)

The Sr^{90} content in a dog was determined by a simple method of attaching a specially-devised, end-window counter to the clamped upper and lower incisors of the animal, and determining the counting rate in the usual fashion. To determine the Sr^{90} content in the whole body, it is necessary to know two coefficients. First, the surface activity of the tooth must be converted to a specific activity (K_1). Secondly, the specific activity of the teeth must be converted to the specific activity of bone (K_2). Here $K_1 = N/A_3$, where N is the external beta activity of the teeth in counts per minute, and $K_2 = A_3/A_\kappa$, where A_3 is the activity in μC per gram of tooth, and A_κ is the activity in μC per gram of skeleton. The experimental value of K_1 was found to be 1.1 to 1.3×10^{-5}. The coefficient K_2 varies as a function of the residence time of the isotope in the body. Its value is 1.35 ± 0.45 for long residence times of Sr^{90} in dogs. Radiochemical studies of Sr^{90} in the bones and teeth of people who died showed that K_2 is close to 1 for adults, and approximately 2 for children. The content of Sr^{90} in a human body can be measured at a level of 0.3 to 0.5 μC with the use of these coefficients. (TTT)

30370 SYNERGISTIC EFFECT OF 5-BROMODEOXYURIDINE AND GAMMA RAYS ON CHROMOSOMES. F. K. S. Koo (Puerto Rico Nuclear Center, Mayaguez). Science, 141: 261-2(July 19, 1963).

The combined effect of 5-bromodeoxyuridine and gamma rays on chromosomes in cells from the root tips of Zebrina pendula is synergistic. The enhanced, combined effects per cell of aberrations, bridges, and acentric fragments were, respectively, 2, 2.4, and 1.9 times the sum of the separate effects. (auth)

30371 SENSITIVITY OF GERMINATING RICE SEEDS TO IRRADIATION DEPENDING ON THE AGE OF SPROUTS. Tsung-lo Lo and I-hsiung Fang. Shih Yen Sheng Wu Hsueh Pao, 7: 123-31(1960).

Rice seeds preliminarily soaked in H_2O at 30°C for various periods of time were x irradiated. Seeds soaked for 24 to 72 hr proved to be the most sensitive to irradiation. The soaking of seeds in 0.5 to 3% NaCl solution increased, and in sucrose solution of the same concentration decreased, their resistance to irradiation. The action of NaCl is explained by the inhibition of growth. (OTS)

30372 EFFECT OF GIBBERELLIN AND INDOLYLACETIC ACID UPON SENSITIVITY OF GERMINATING RICE SEEDS TO X-RAYS. Tsung-lo Lo and I-Hsiung Fang. Shih Yen Sheng Wu Hsueh Pao, 7: 132-7(1960).

The soaking of rice seeds in solutions of indoleacetic acid and gibberellic acid decreased their resistance to x irradiation and increased the intensity of growth processes. It is assumed that the sensitivity of the organism to irradiation is determined by the intensity of the growth. (OTS)

30373 THE EFFECT OF IONIZING RADIATION ON THE PHYTONCIDAL ACTIVITY OF WHITE MUSTARD (SINAPIS ALBA). L. D. Efrimova. Tr. Yaroslavsk. Med. Inst., 25: 283-4(1960).

Soaked seeds of white mustard were initially irradiated by 750, 1000, 5000, 10,000, and 20,000 r doses. The phytoncidal activity, both of the controls and of the irradiated seeds, did not change but remained at the previous weak level. The phytoncidal activity of the seedlings grown from the seeds that were irradiated by large x-ray doses (5000, 10,000, and 20,000 r) was noticeably depressed as compared with the activity of the control seedlings. (OTS)

30374 INCREASED VARIABILITY IN FIRST-GENERATION TOMATO PLANTS FOLLOWING BETA-RAY (P^{32}) IRRADIATION. V. S. Sarma and A. K. Roy Choudhury. Trans. Bose Res. Inst. (Calcutta), 25: 17-19 (Mar. 1962).

Increased variability and variances in time of germination, time of flowering, height of plants, number of branches, number of fruits, and yield of fruits resulted in first generation tomato plants grown from seed treated with P^{32}. (C.H.)

30375 EFFECT OF RADIOACTIVE ISOTOPE ON THE FLOWERING BEHAVIOUR OF JUTE (CORCHORUS OLITORIUS LINN.). A. Das and A. K. Roy Choudhury. Trans. Bose Res. Inst. (Calcutta), 25: 21-3(Mar. 1962).

Following irradiation with S^{35}, the dispersion of the flowering time of jute was increased in the first generation. The genetic variability of the treated population in the second generation was found to be greater than that of control population by two and a half times. But owing to the largeness of environmental variation, poor heritability of the flowering time was noticed. (auth)

30376 STUDIES ON THE MORPHOLOGICAL MUTANTS OF STREPTOMYCES ALBOSPORUS, STRAIN Ac_{21} (460). Sankar Lal Chakrabarty and P. Nandi. Trans. Bose Res. Inst. (Calcutta), 25: 29-36(Mar. 1962).

By ultraviolet irradiation of a pink-colored Streptomyces, strain Ac_{21} (460), a number of morphological mutants were obtained. Out of these, 6 stable mutant strains were selected for detailed studies. It was observed that temperature, light, and pH did not modify the nature of the morphological mutants. The strains were not biochemically deficient and as such they differed physiologically. Maltose when supplied to the medium as carbon source helped to diffuse the pigment produced by each of the mutant strains into the culture medium. Thus it might be possible that sugar-breaking enzymes were responsible for inducing morphological change by controlling some of the recessive gene factors. (auth)

30377 THE LEVELS OF FREE ASPARTIC ACID, GLYCINE, AND SERINE IN TISSUES OF BONE MARROW CHIMERAS. A. L. Kretchmar and C. C. Congdon (Oak Ridge Inst. of Nuclear Studies, Tenn. and Oak Ridge National Lab., Tenn.). Transplantation, 1: 298-305(July 1963).

Aspartic acid concentration is increased in liver of irradiated mice treated with foreign bone marrow. The serine and glycine concentration of liver, plasma, and muscle is decreased in these animals. The rate of which aspartic acid is labeled by carbon-14 injected as carbon-14 glucose is different in foreign marrow chimeras as compared to isologous marrow treated irradiated mice. This suggests that the increase in aspartic acid of liver is due to a fundamental alteration in metabolism of this amino acid in foreign marrow chimeras. (auth)

30378 TRANSPLANTATION OF PERITONEAL FLUID CELLS. Joan Wright Goodman (Oak Ridge National Lab., Tenn.). Transplantation, 1: 334-46(July 1963).

Several criteria, including survival of chimeras, Fe^{59} uptake, microscopic appearance of stained, fixed tissues, and serological identification of erythrocytes and nucleated hemopoietic cells, have been used to show that peritoneal fluid cells of the mouse can, on transplantation to a heavily irradiated host, proliferate and differentiate into apparently normal, permanent hemopoietic and lymphopoietic tissues.

The efficiency of peritoneal fluid cells is far smaller than that of bone marrow cells and appears to be like that of white cells from circulating blood of the normal mouse. (auth)

30379 NOTES ON THE PROBLEMS OF THE TRANSPLANTATION OF KIDNEYS IN DOGS. A. Puza, V. Drahovský, E. Neubauer, M. Klimeš, and M. Kňazovicky (Šafarik Univ., Košice, Czechoslovakia). Transplantation, 1: 385-8(July 1963). (In English)

In a group of 29 mongrel dogs kidney homotransplantation was performed. In five dogs an autograft was performed to check the suitability of the surgical technique. In the remaining 24 dogs kidney homografts were carried out. Five dogs served as controls; in these animals the functioning of the homografted kidney stopped after 8 days on the average. In 12 animals an attempt at the induction of immunological tolerance by exsanguinotransfusion, whole-body irradiation and 6-MP-administration was made. Induction of immunological tolerance by total exsanguinotransfusion immediately after birth may render possible a successful homograft even in adult life. The transplanted organ then exhibits a permanent take and takes over the function of the recipient's removed kidneys. One dog is alive with its single kidney homograft after almost two years. 6-MP administration may lead to such a degree of induced tolerance that the function of a kidney homograft is prolonged by a factor of two to three. Whole-body irradiation within a range of 400 rad (Co^{60} source) does not significantly prolong homograft survival. (auth)

30380 SUBLETHAL TOTAL BODY IRRADIATION AND RENAL TRANSPLANTATION. R. M. Mitchell, O. E. Budtz-Olsen, B. G. Stevens, and G. A. Devereux (Univ. of Queensland, Australia). Transplantation, 1: 388-90(July 1963).

Survival of kidney transplants in sheep following a sublethal dose of x radiation was investigated using 20 unrelated merino sheep. Total body irradiation doses of 350–450 r were given the animals using a 4-Mev linear accelerator at a distance of three meters. Half the dose was administered from each side. After 48 hours the left kidney of the donor was inserted into the right side of the recipient. Results indicated that the irradiation technique did not prolong the function of the kidney homografts in sheep. However, lymphocyte and plasma cell infiltration did not occur under these conditions. (H.M.G.)

30381 BIOLOGICAL EFFECTS OF IONIZING RADIATION ON MOLECULAR LEVEL. Ferdinand Hercik (Biophysical Inst., Czechoslovak Academy of Sciences, Brno). Vestn. Cesk. Akad. Ved., No. 5, 532-5(1962).

Under the sponsorship of the International Agency for Atomic Energy in Vienna, a scientific symposium was convened by the Czechoslovak Academy of Sciences and the Czechoslovak Atomic Commission on July 2 to 6 in Brno to deal with the radiation effects on albumins and nucleic acids. Papers on the following subjects were presented in six sessions: Drášil, Czechoslovakia, reported on processes in irradiated tumor cells; Belyayeva, USSR, studied the changes in albumins during first post-irradiation phases; Kanazir, Yugoslavia, and his collaborators dealt with changes of the nucleic-acid structure, synthesized in bacteria after exposure, and, in another paper, with the favorable effects of high-polymerized desoxyribonucleic acid on the metabolic activity of the liver and intestines in rats exposed to a lethal dose; Lazurkin, USSR, studied the kinetics of processes leading to formation of free radicals in albumins during exposure; Cherkasova, USSR, dealt with the post-irradiation metabolism of albumins in the central nervous system; Beneš and Soška, ČSSR, reported on the effects of some pyrimidine precursors of desoxyribonucleic acids on the resumption of nucleic-acid synthesis after it had been stopped by ionizing radiation; Karpfel, ČSSR, reported on increased cell division rate and formation of abnormal chromosomes in irradiated marrow of animals to which intact desoxyribonucleic acid was previously administered; Petrová, Czechoslovakia, dealt with the direct and indirect effects of radiation on Zygnema algae; Skalka, Czechoslovakia, and his collaborators studied radiation effects on the bond between desoxyribonucleic acid and albumin; Hradečná, Doctor, Czechoslovakia, dealt with radiation effects on some functions of lambda-phage; Drobník, Czechoslovakia, reported on effects of internally administered phosphorus on diploid yeast cells. (OTS)

30382 THE COURSE OF DAMAGE TO THE CENTRAL NERVOUS SYSTEM IN ANIMALS IRRADIATED WITH X-RAYS. L. S. Gezalyan (Radiobiological Section, Academy of Sciences, Armenian SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 59-67(1960).

An investigation was conducted on the separate and combined effects of lesions of the central nervous system and irradiation in tortoises. Eight tortoises were subjected to hemisection of the spinal cord at the level of the first cervical vertebra. This was followed by a marked reduction in the tone of the muscles of the hind limbs, particularly on the operated side, followed after 2 to 6 hours by some recovery of function, and subsequently by an increase in tone on the operated side. The skin sensitivity threshold of the hind limbs rose after operation, and there was a reduction in chronaxie followed by a rise, which returned to normal values after 8 to 10 days. A second group of 8 tortoises was subjected to hemisection followed immediately by x-irradiation in a dose of 5016 r. The tone of the muscles of the hind limbs was increased, but the tone of the muscles on the side of section fell after 4 to 5 days and the limb did not participate in locomotion. The skin sensitivity threshold on the operated side fell on the second day; this was followed by a rise which persisted for 10 to 12 days. On the unoperated side the threshold rose after section and remained at a high level. The chronaxia of the muscles of both hind limbs fell abruptly (from 1 to 0.2 v) and remained low until the death of the animal. In 8 other tortoises which were irradiated without previous spinal section there was no change in muscle tone in the hind limbs, but the skin sensitivity threshold rose markedly from 5 to 35 v and there was a fall in chronaxia. Similar experiments were carried out in white rats with lesions of the cerebellum, and it was found that the neurological disturbances were intensified by irradiation. (OTS)

30383 THE COURSE OF THE MORPHOLOGICAL AND CERTAIN HISTOCHEMICAL CHANGES IN THE SPLEEN AND LYMPH NODES AFTER GENERAL X-IRRADIATION. E. E. Pulatova (Radiobiological Section, Academy of Sciences, Armenian SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 79-85(1960).

The presence of ribonucleic and deoxyribonucleic acid, inorganic and organic iron was determined by appropriate histochemical methods in preparations of the lymph nodes and spleen of white mice removed at intervals up to 72 hours after subjection to a lethal dose (800 r) of x-irradiation. In the spleen, pyknosis of the nuclei of the lymphocytes was observed one hour after irradiation; after 3 hours the confines of the Malpighian bodies became indistinct and the lymphocytes in the centers were mainly destroyed. Accumulations of inorganic iron appeared at the same time in the reticular cells. After 12 hours nearly all

the lymphocytes were destroyed, and many macrophages containing fragments of cells were present; plasma cells rich in ribonucleic acid were accumulating around the central arteries. The accumulation of inorganic iron continued up to 48 hours. Similar changes were noted in the lymphocytes and other cellular elements of the peritoneal lymph nodes. (OTS)

30384 AUTOLYSIS OF THE BLOOD IN RADIATION INJURY. R. G. Mkrtchyan (Radiobiological Section, Academy of Sciences, Armenian SSR and Moscow State Univ.). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 93-101(1960).

The rate of autolysis of the blood of rats before and after exposure to x-irradiation in a dose of 600 to 1000 r was investigated. Citrated blood diluted 1 : 20 with saline was incubated at 37°C for 8 hours, and the extent of autolysis was determined from the content of amino nitrogen after precipitation of protein with trichloroacetic acid. Blood taken 3 hours after irradiation showed 2 to 3 times as much autolysis as the pretreatment sample, and the increase in extent of autolysis continued until 7 to 8 days after irradiation. During this time, there was a marked fall in the content of amino nitrogen in the blood in vivo. The results indicate that increased autolysis of the blood is one of the earliest manifestations of radiation sickness. (OTS)

30385 THE ACTION OF ULTRAVIOLET RAYS ON PATHOGENIC SEROTYPES OF ESCHERICHIA COLI. R. A. Ter-Pogosyan and Z. P. Goryainova (Radiobiological Section, Academy of Sciences, Armenian SSR and Dnepropetrovsk Inst. of Medicine, USSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 123-5(1960).

Two drops of 24-hour cultures of the serotypes 0111, 055, 026, 0125, 0126, 086, 044, 025, 408, and 145 of Escherichia coli were placed on 0.5 × 2 cm test pieces, which were then irradiated with an ultraviolet lamp at various distances and for various periods of time. The organisms were then tested for survival by culture in broth followed by plating on Endo medium. The results showed that there was some variation in sensitivity among the different serotypes; 025 and 145 were the most resistant, and 026 and 0126 the most sensitive. All the serotypes were destroyed by ultraviolet radiation when placed at a distance of 35, 75, or 150 cm and exposed for 10, 90, and 150 minutes, respectively. The use of mercury-quartz lamps for therapeutics and prophylaxis in cases of colienteritis is recommended. (OTS)

30386 EXCHANGE OF IRON-CONTAINING SUBSTANCES IN ORGANS OF THE ANIMAL ORGANISM AFTER TOTAL-BODY X-IRRADIATION. S. E. Manoylov, Wen-mei Shen, and E. I. Shcherban. Vopr. Radiobiol., Tsentr. Nauchn.-Issled. Inst. Med. Radiol., 4: (1960), 184-8(1961).

Twenty-four hr after whole-body x irradiation, at a dose of 1000 r, Fe^{59} was introduced into mice in the form of ascorbinate in the amount of 3 μC per 20 g of weight, and its specific activity in the organs was determined after ½, 1, 2, 4, 24, and 48 hr. Chemically, Fe was determined by a phenanthroline method. The rate of Fe^{59} incorporation in the liver increased, whereas it decreased in the spleen. Absorption in the kidneys was undulatory and exceeded the incorporation in control unirradiated animals. Coincident results were obtained using the histoautographic method. Apparently, as a result of x irradiation, the process of formation of hemoglobin and heme is arrested and Fe exchange in the organism is also disturbed, which is responsible for its irregular excretion by the kidneys. (OTS)

30387 THE QUESTION OF THE EFFECT OF THE CHRONIC ACTION OF IONIZING RADIATIONS ON THE CAPABILITY OF THE ORGANISM TO ELABORATE ANTI-INFLUENZA ANTIBODIES. G. I. Erlikhman. Vopr. Virusol., 8: 248(Mar.-Apr. 1963).

The action of ionizing radiations on the capability of the white mouse organism to elaborate virus neutralizing antibodies was studied. The mice were subjected to gamma irradiation for 12 weeks of their growth period at doses of 1, 2, and 3 r per day. Total doses consisted of 84, 168, and 252 r, respectively. The mice were given live vaccine against type A_2 influenza virus. A decrease in the capability of the experimental animals to elaborate antibodies in comparison with the controls was evident following all three irradiation doses. (OTS)

30388 THE EFFECT OF PLUTONIUM-239 AND OF STRONTIUM-89, 90 ON THE BONE MARROW OF WHITE RATS. S. R. Tsarapkin and Z. G. Sych. p.284-9 of "Raspredelenie, Biol. Deistvie i Migratsiya Radioakt. Izotopov." Moscow, Medgiz, 1961.

Solutions of Sr^{89} and Sr^{90} of 1.5 mC/g and Pu^{239} of 0.0035 mC/g were administered intraperitoneally to rats. Four rats of each group were sacrificed on the 3rd, 8th, 16th, and 32nd day. Bone marrow samples were taken from the femoral bone, and, after mixing the marrow with blood serum, smears were prepared. Readings showed that the erythroblastic part of the bone marrow was injured before and to a greater degree than the granuloblastic part of the bone marrow. The Pu effect was greater on the bone marrow; it injured the undifferentiated cells (reticuloendothelial, and plasmatic). Strontium-89 and -90, just as in external irradiation, had almost no effect on the cells. (OTS)

30389 CERTAIN PHYSIOLOGICAL AND PHARMACOLOGICAL EFFECTS OF RADIATION ON RABBITS. Edwin Gan Wagelie. Thesis, Corvallis, Oreg., Oregon State Univ., 1963. 203p.

Rabbits of three breeds that vary greatly in body size were irradiated with 100 r and 300 r cumulative doses. Hematological, intestinal motility, and ear vascularity examinations were performed. Least square estimates have been obtained and an analysis of variance was conducted in order to estimate the effects of breed, sex, radiation, and interaction of breed times sex, breed times radiation, sex times radiation, and breed times sex times radiation upon each of the 116 dependent variables used in this study. (H.M.G.)

30390 RADIATION INHIBITION OF SALMONELLA IN EGG PRODUCTS. G. W. Anderson (Ontario Agricultural Coll., Guelph). 6p. (CONF-9-1)

From CNA International Conference on the Operating Experience and Future Development of Power Reactors and on Radioisotopes, Montreal, May 1963.

The effects of gamma radiation on Salmonella in frozen egg products are described. It was found that radiosensitivity was not consistent among different species. A marked reduction in the aerobic bacterial count was obtained with a dose level of 0.20 Mrad. It was evident that gamma radiation possesses a distinct potential as a means of removing the Salmonella problem from frozen whole egg products. Data are tabulated. (P.C.H.)

30391 CYTOLOGIC ANALYSIS OF BARLEY SEEDS GAMMA-IRRADIATED IN THE STATE OF ORGANIC REST (PECULIARITIES IN THE FORMATION OF CHROMOSOME ABERRATIONS, OXYGEN EFFECT). N. I. Nuzhdin and R. L. Dozortseva. p.5-30 of "Deystvie Ioniziruyushchikh

Izluchenii na Organizm." Moscow, Publishing House of the Academy of Sciences, 1962.

After a comprehensive review of Soviet and Western sources, the present experiments are described. Three types of barley seed with different organic rest periods and radiosensitivity, i.e., Moscow winter (A), Odessa-17 (B), and Yugoslav winter (C), were Co^{60} irradiated with 12 C. The frequency of radiation-induced formation of chromosome bridges in the cells of the rootlets was investigated for each barley sort in 3 groups of seeds after passing out of the state of organic rest either: (1) spontaneously; (2) artificially after removal of the seed coat and puncture near the seed bud, with immediate germination; (3) as (2), but with germination after 10 or 20 days. In all 3 barleys the chromosome aberrations were ~100% higher in groups 1 and 3 than in 2. To resolve the controversies on the cause of organic rest, which many authors attribute to anoxia, the effect of N_2, O_2, air, and vacuum on the number of chromosome aberrations was studied in a further series of tests where A and B were irradiated in organic and induced rest. The results are represented by the order $I^O = I^A = \underset{\sim 25\%}{III^O} = III^A > I^N = I^V = \underset{\sim 7\%}{II^O} = II^A = III^N = III^V > II^N = II^V$, (3%), where I are seeds irradiated in organic rest and kept in induced rest after this; II are seeds treated as in I, but germinated immediately after leaving the state of rest; III are seeds irradiated in induced rest; N = nitrogen; O = oxygen; A = air; and V = vacuum. Two previous assumptions are confirmed: The state of organic rest is the result of anoxia caused by the impermeability of the seed coat to oxygen. Irradiation produces real and potential breaks of chromosomes; under the effect of O_2 the potential breaks develop to real breaks (the aberration percentage increases), and in the complete absence of O_2 they disappear. (OTS)

30392 TRANSFER OF THE INDIRECT EFFECT OF IONIZING RADIATION. O. I. Domareva. p.162-6 of "Deystvie Ioniziruyushchikh Izluchenii na Organizm." Moscow, Publishing House of the Academy of Sciences, 1962.

It is sought to clarify the transfer mechanism of the indirect radiation effect from the change that occurs in adrenalin excretion of the medulla of the suprarenal gland in mice irradiated with x rays. The mitotic activity of the cornea of male mice is studied. This activity may be reduced in the case of whole-body irradiation by direct damages of the nucleus (avoided by shielding the head) but also by a change in the adrenalin level (neurohormonal, indirect radiation effect). When 600 r were given (68.7 r/min) the cornea was fixed two hours after irradiation. Group I includes the mice irradiated under shielding of head and suprarenal gland, or of head only. In both cases the number of dividing cells is practically the same, but less by ~25% than in the control animals not irradiated. In group II, the suprarenal glands were extirpated, and after three days the animals were irradiated with only the head shielded. The cornea was fixed (a) two, and (b) six hours after irradiation. There is no difference in the mitotic activity both in (a) and (b), as compared with the control animals not irradiated but in other respects treated identically. This is in contrast with the results in group I. The experimental results suggest that irradiation acts indirectly upon the mitosis in the cornea, i.e., by reflex effect on the hormonal activity of the suprarenal gland. (OTS)

30393 PROTECTION OF THE SKIN AGAINST X-RAYS WITH DELIAL. I. Leondarakis. Thesis, Gottingen, Ger., Universität, 1961. 64p. $2.00.

The effect of Delial on erythema of 10 patients of age between 20 and 30 years after single x irradiations of 1000 r and fractionated irradiations of 10 times 200 r daily is studied. For 7 of 10 patients, apparation of erythema was delayed on the average for 10 days. It is concluded that Delial gives no protection against erythema. (Gmelin Inst.)

30394 EFFECTS OF SUBLETHAL X-RAY DOSES ON ORGANS WITH HIGH RADIATION SENSITIVITY ESPECIALLY ON FEMALE GENITAL GLANDS AND ON FOETUSES IN UTERO. J. Trautmann. Thesis, Berlin, Freie Universität, 1961. 207p. $2.00.

The effects of small radiation doses are reviewed. Changes in organs of mice and rabbits after irradiation with sublethal doses are studied. Damages in female genital glands and fetuses of mice are investigated. (Gmelin Inst.)

30395 ENZYMATIC AND HISTOCHEMICAL CHANGES INDUCED BY THERAPEUTIC APPLICATION OF IONIZING RADIATION. K. H. Kaercher. Thesis, Heidelberg, Universität, 1961. 208p. $2.00.

Progress in enzymology and histochemistry in clinical diagnosis are reviewed. Enzyme activities in serum and tumor tissues before and during irradiation or isotope applications were studied. Inhibition of radiation effects by partial shielding of various organs is discussed. Methods for medical treatment of skin damages by ionizing radiation are given. (Gmelin Inst.)

30396 EXPERIMENTAL STUDIES ON THE ALTERATION OF THE RADIATION SENSITIVITY OF MAMMALS. H.-J. Melching. Thesis, Freiburg i. B., Universität, 1962. 253p. $2.00.

The increase of radiation resistance of mammals by various organic compounds is studied. The greatest protection effect is produced by Serotonin. The metabolism of this compound and of its precursors was investigated. Possible applications of protective substances in radiation therapy are discussed. (Gmelin Inst.)

30397 DEPENDENCE OF RADIATION INDUCED MUTATION RATE ON MATURITY AND DOSE FOR CHRYSALIS OF DROSOPHILA MELANOGASTER MEIGEN. W. Ebeling. Thesis, Darmstadt, Ger., Technische Hochschule, 1962. 100p. $2.00.

The dependence of the rate of radiation-induced recessive sex-linked lethal factors and II–III translocations on dose and maturity of germ cells of 174-hr old chrysalis are studied. For the translocation curves, an exponent of approximately 1.5 was observed. Dose curves for lethal factor have an exponent smaller than unity. This can be explained by assuming that for increasing dose a larger fraction of lethal factors for which at last two events are necessary is produced. (Gmelin Inst.)

30398 EFFECTS OF RADIATIONS OF NATURAL POPULATIONS OF VERTEBRATES. W. Frank Blair (Univ. of Texas, Austin). p.1377-81 of "Recent Advances in Botany." Toronto, University of Toronto Press, 1961.

The question is raised as to what effects ionizing radiations may have on natural populations through their effects in increasing mutation rates, since such populations presumably exist in equilibrium between genetic change and selective pressures. Radiation-induced mutations are of the same general type as those which occur spontaneously and are predominantly lethals or ones with invisible effects. In Peromyscus maniculatus and P. leucopus, the effects of dominant lethal mutations are seen in reduced litter size. In Bufo valliceps both dominant lethals and visible mutations (pigment deficiency and growth abnor-

mality) have been found, and frequency of mutation is proportional to dose. Natural populations of the two species of mice and of the toad have maintained their population numbers under a regime of increased mutation rate through gonadal X-irradiation of males with doses of 300r to 700r. Heavy attrition on each generation and consequently heavy selection pressure appears to be a major factor in the continued success of the experimental populations. The results obtained with these populations cannot be extrapolated to man. (auth)

30399 AN IMMUNOLOGICAL APPROACH TO THE STUDY OF RADIATION-INDUCED BLOOD CHIMERAS. T. Makinodan, Franco Celada, and Elmo E. Capalbo. p.155-61 of "Proceedings of the VIIIth International Congress of Hematology, Tokyo, September 1960." Tokyo, Pan Pacific Press.

The mechanism of antibody formation as affected by radiation and transplantation antigens was investigated by a study of the relation of cell number and antibody response. A known number of H^3-thymidine labeled spleen cells was injected intravenously into heavily x-rayed isologous mice and the test antigen was injected intraperitoneally immediately thereafter. By varying the spleen cell dosage, a linear log-2 relation between primary or secondary antibody response and spleen cell number is demonstrated. It was concluded that the difference in the radiosensitivity of nonprimed and primed individuals lies mainly in the number of viable spleen-like cells per gram of adult mouse. A new model for transplantation antigens is described. (H.M.G.)

Radiation Sickness

30400 (TID-19041) THE EFFECT OF EMBRYONIC IRRADIATION ON ADULT LIFE EXPECTANCY AND ADULT PATHOLOGY. Sixth Year Progress Report, November 1, 1957– June 30, 1963. (Jefferson Medical Coll., Philadelphia). Contract AT10(30-1)-2071. 13p.

Progress is reported in studies on the effects of embryonic irradiation on adult life expectancy and adult pathology of mice. A list is included of publications during the period covered by this report. (C.H.)

30401 SOME CHARACTERISTICS OF THE HIGHER NERVOUS ACTIVITY OF ANIMALS EXPOSED TO IONIZING RADIATION IN UTERO. V. CHARACTERISTICS OF THE HIGHER NERVOUS ACTIVITY IN EARLY POSTNATAL ONTOGENESIS IN PUPPIES IRRADIATED DURING EMBRYONIC DEVELOPMENT. I. A. Piontkovskii and M. G. Ayrapetyants (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Byul. Eksperim. Biol. i Med., 55: 26-31(1963).

Six bitches were totally irradiated with 200 r x rays on the 20th or 45th day of pregnancy or were left untreated. Puppies from irradiated bitches showed a number of vegetative nervous disorders from the first days of life, pulse and respiration rates increased, and urination, defecation, and regurgitation were frequent. Development was uneven and retarded in all but 1; the variation in weight between individuals was up to 15%, compared with 10 to 15% in controls. Leucopenia occurred in trial puppies especially in those irradiated as 45-day embryos. At birth and up to 30 days of age they had fewer red cells per mm^3 blood. Hb fell in both groups, most in trial puppies, especially after irradiation at 45 days in utero when the values fell by about 50%. In all controls a conditioned olfactory motor feeding reflex was formed on the 1st day; in trial puppies it occurred somewhat more slowly and with a mixed response. Intensity, duration, and direction of motor reactions in response to the smell of camphor were considerably more distinct in controls. When conditioned reflex activity was studied by the shaking method from the 10th day reflexes, especially differentiation, appeared in the trial puppies. Data from both methods show that from birth to 2 months the closing function of the cerebral cortex in puppies irradiated in utero was considerably weaker than in controls. Occurrence of paradoxic and ultraparadoxic reactions indicated a low level of activity in the cortex cells. There were similar changes in higher nervous activity in both groups of irradiated puppies, but neurodynamic disturbances, especially the processes of internal inhibition, were more marked in those irradiated on the 45th day in utero. (OTS)

30402 ANTITOXIN FORMATION BY CELLS TRANSPLANTED TO IRRADIATED ANIMALS. D. P. Kaulen (Inst. of Epidemiology and Microbiology, Moscow). Byul. Eksperim. Biol. i Med., 55: 61-5(1963).

The aim of the work was to study, in conditions of normal subcutaneous immunization, which transplanted cells form antitoxin, the significance of the phase of antibody formation, the immunological response of cells to stimulation by 2 unrelated antigens, and to find whether transplanted cells are capable of a secondary immunological response. Donor animals were immunized subcutaneously: guinea pigs twice, with a 30-day interval, with adsorbed diphtheria toxoid, or once with native toxoid; rabbits simultaneously with 2 antigens, the diphtheria toxoid and typhoid formol vaccine, once or several times over 30 days. Recipient animals were exposed to x rays, guinea pigs to 200 or 525 r, and rabbits to 550 or 800 r, and injected intravenously 2 to 4 hr later with cell suspensions prepared from donor spleen, lymphatic nodes, or bone marrow or, for controls, with cells killed by heating. In 3 trials to study the inductive phase of antibody formation, cells were taken from donors 24 hr after single immunization. In guinea pigs exposed to 200 or 525 r and in rabbits to 550 r, there was no sign of anti-diphtheria antitoxin or, in the rabbits, agglutinins during 30 days after transplantation of cells. In 4 trials of antibody production by cells taken in the reproductive phase, all transplanted tissues formed, in up to 10 days, detectable amounts of antitoxin in guinea pigs, except bone marrow in those exposed to 200 r; killed cells produced none. In rabbits exposed to 550 r, transplanted cells formed antibodies to both antigens used; they appeared by the 3rd day, reached a maximum on the 6th, fell rapidly by the 15th, and were not detectable by the 30th day. The pattern was similar for both antigens. Basically the same results were obtained in rabbits exposed to 800 r. When recipient animals were injected with diphtheria toxoid and formol vaccine on the 15th day after transplantation, no antitoxin was formed but agglutinin titer rose in all animals, even in those injected with killed cells. (OTS)

30403 DAILY PERIODICITY OF MITOSES IN MICE AFTER EXPOSURE TO γ RAYS. L. P. Kosichenko (Inst. of Experimental Pathology and Therapeutics, Sukhumi, USSR). Byul. Eksperim. Biol. i Med., 55: 114-17(1963).

Male albino mice weighing 18 to 20 g were exposed to 190 or 400 r total γ irradiation and groups were killed at 6-hr intervals on the 5th day after irradiation. In irradiated mice and in controls, the number of mitoses in corneal epithelium was highest at 8 a.m. and lowest at 8 p.m. There was no significant difference between the groups in average daily numbers or in numbers at different times of the day except that irradiated mice had significantly more

at 2 a.m. In a second series of trials similar results were obtained; there was a slightly, but not significantly, higher activity in irradiated mice at 2 a.m. and 2 p.m. In both trials the number of mitoses at 2 p.m. in the peripheral and central regions of the cornea were similar in irradiated mice, but controls had more in the central region than in the periphery. At 2 a.m. activity was increased in the periphery in both groups. It is concluded that the amounts of radiation used in these trials had no significant effect on the mechanisms governing the daily periodicity of cell multiplication. (OTS)

30404 HISTOCHEMICAL STUDY OF EXPERIMENTAL PNEUMONIA IN ACUTE RADIATION SICKNESS. A. E. Ivanov and N. N. Kurshakova. Federation Proc., 22: T488-93(May-June 1963). (Translated from Arkhiv Patolog., 24: No. 8, p.56, 1962).

A considerable difference is seen in the character of the metabolic disturbances in pneumonic foci and in the surrounding lung tissue in irradiated and unirradiated animals. Infection, superimposed on acute radiation sickness, aggravates the disturbances of tissue metabolism caused by ionizing radiation. In turn, these disturbances to some extent determine both the distinctive features of the pneumonia arising in the irradiated animal and the character of the regenerative processes developing after the inflammation. The degree and time of appearance of the disturbances that occur in tissue metabolism during the development of experimental pneumonia in irradiated animals depend on the period of the radiation sickness in which the inflammatory process is induced. (auth)

30405 THE EFFECT OF VITAMIN B_1 ON ANAPHYLACTIZED ANIMALS UNDER THE INFLUENCE OF IONIZING RADIATION. A. F. Leshchynskii (Odessa Pharmaceutical Inst.). Fiz. Zh., Akad. Nauk [illegible]. SSR, 8: 818-19 (1962).

Experiments were made to determine the effect of vitamin B_1 on irradiated animals, using 30 guinea pigs of both sexes, of weight 240 to 300 g, sensitized with normal equine serum given subcutaneously at 0.1 ml. Re-injection was on the 19 to 20th day, at 0.8 ml. Vitamin B_1 was given in the form of 3% thiamine bromide solution started 7 days before re-injection, at 6 mg, subcutaneously. The first serum injection was given 24 hours after a total x-ray dose of 100 r. There were three experimental series: (1) to determine the effect of vitamin B_1 on irradiated and subsequently sensitized animals; (2) on sensitized animals which were not irradiated; and (3) to determine the effect of x-ray irradiation on sensitized animals. Results showed that x-ray irradiation prior to equine serum injection inhibited the development of anaphylactic shock and considerably reduced anaphylaxis. The desensitizing action of thiamine was also confirmed. Injection of B_1 into sensitized irradiated animals had no desensitizing effect. Study of the blood showed disruption characteristic of irradiation effects and changes peculiar to allergic conditions and anaphylactic shock. (OTS)

30406 POTENTIAL RADIATION-PROTECTIVE COMPOUNDS. SYNTHESIS OF THE THREE ISOMERIC THREE-CARBON AMINOHYDROXY BUNTE SALTS AND RELATED COMPOUNDS. D. H. Ball, J. M. Williams, and L. Long, Jr. (Army Natick Labs., Mass.). J. Org. Chem., 28: 1589-93(June 1963).

The isomeric internal Bunte salts, S-3-amino-2-hydroxypropylthiosulfuric acid, S-2-amino-1-(hydroxymethyl)ethylthiosulfuric acid, and S-2-amino-3-hydroxypropylthiosulfuric acid, were prepared as the racemic forms. The last named was also prepared in a levorotatory form. 3-Amino-2-bromo-1-propanol hydrobromide was synthesized by the addition of hypobromous acid to the allylammonium ion; the isomeric 1-amino-3-bromo-2-propanol hydrobromide was a minor product of the addition. The acid hydrolysis of N,O,S-triacetyl-l-cysteinol probably proceeds via a thiazoline intermediate. (auth)

30407 THE EFFECT OF BONE MARROW ON THE REGENERATION OF THE LIVER IN NORMAL AND X-RAY TREATED RATS. Endre Czeizel, Gyoergy Vaczó, and Pál Kertai (Istvan Hospital, Budapest). Magy. Radiol., No. 2, 113-17(1962).

The regeneration of the liver in rats is increased by extract of bone marrow. On the other hand, irradiated suspension of bone marrow has a strong inhibitory effect upon liver regeneration. Radiation therapy of the whole body reduces the regeneration of the liver, even when the liver region is protected by lead plate. The inhibitory effect is mitigated, if not prevented, by the administration of bone marrow suspension. Bone marrow irradiated in vitro had no effect. (OTS)

30408 FREEZE-DRYING AND RADIATION PROTECTION. A. M. Cook, T. A. Roberts, and Jean P. Widdowson (London Univ.). Nature, 199: 194-5(July 13, 1963).

Freeze-drying from certain carbohydrates afforded protection against radiation injury of Bacillus subtilis spores and Escherichia coli. The protective effect was not demonstrated when the organisms were freeze-dried from water. (C.H.)

30409 MORPHOLOGICAL CHANGES IN NERVES OF BONE TISSUES OF ANIMALS DURING ACUTE RADIATION SICKNESS. M. N. Pavlova. Ortoped. Travmatol, i Protezirovan., No. 2, 9-14(Feb. 1963).

Tests on rats irradiated by 600 or 900 r showed morphological changes in the nerve fibers of bone tissue, such as varicose thickening of axis cylinders, break up of neurofibrils, vacuolation of the myeline sheath, granular-mass fragmentation, and resorption in the haversian canals, periosteum, and endostrium. The pathological changes in the nerve fibers were irreversible; and under such conditions, normal innervation of bone tissues was disrupted. A definite relation became evident when data on the degree of bone and nerve tissue injury were compared with the development of pathological changes in the tissues during radiation sickness. (OTS)

30410 ELECTROPHORETIC STUDIES ON THE HEMOGLOBIN OF DOGS EXPOSED TO PENETRATING RADIATION. B. F. Sukhomlinov, V. V. Merenov, and N. N. Semenchuk. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 3-7(1962).

Studies were made on the electrophoretic mobility of hemoglobin in dogs exposed to x rays, and also the adsorption curves of oxyhemoglobin in the visible part of the spectrum. Acute radiation sickness was produced in dogs of 6 to 12 kg weight by a single exposure to a dose of 600 to 800 r from a distance of 1 m, at a rate of 14 r/min. Electrophoresis of the hemoglobin was carried out repeatedly in agar gel by the method of Monnier and Fischer. The adsorption curves of the hemoglobin solution were studied by means of a spectrophotometer, and the amino acid composition of the hemoglobin was established by chromatography. The hemoglobin was investigated at regular intervals until the animals' death. The results showed that, in healthy dogs, hemoglobin behaves as a homogeneous sub-

stance under electrophoresis and migrates at a uniform speed towards the cathode. After exposure to radiation, the electrophoretic mobility of hemoglobin decreases and the substance migrates more slowly if the radiation sickness produced has been severe. In those cases in which the change in the velocity of migration was less marked, the radiation sickness proved to be milder and more free of complications. The intensity of the changes varied in definite phases which coincided with the phases of radiation sickness. The adsorption curves of the oxyhemoglobin solution, on the other hand, were completely identical in both irradiated and control dogs. From these facts, it is concluded that radiation affects mainly the synthesis of the protein component of the hemoglobin molecule but does not affect the pigment hem. This conclusion could be confirmed by chromatographic analysis which showed significant changes in the amino acid structure of the hemoglobin molecule after exposure to radiation. (OTS)

30411 THE ELECTROPHORETIC PATTERN OF SERUM AND LIVER PROTEINS AFTER EXPOSURE TO IONIZING RADIATION. B. F. Sukhomlinov, V. D. Edkina, and A. N. Yakovenko. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 8-25(1962).

An electrophoretic investigation was conducted on the serum protein fractions, and the soluble proteins of dogs exposed to radiation. Dogs weighing 8 to 25 kg were exposed to a single dose of x rays ranging from 600 to 1000 r from a distance of 1 m, at 14 r/min. Blood samples were taken under standard conditions from the saphenous vein. The soluble proteins of the liver were obtained by in vitro perfusion, which yielded a solution containing up to 4% soluble proteins. The electrophoresis was carried out on agar gel, with a field of 4 v/cm and current of 18 to 20 ma, at pH 8.6, on 12 to 15 cm strips. Six to 8 fractions were obtained from the serum proteins and 10 to 15 fractions from the soluble liver proteins within 3.5 to 4 hours. From the electrophoretic strips of the serum of healthy dogs, 6 to 8 well-separated fractions (albumins, α_1- and α_2-, β_1-, β_2-, and γ-globulins) were found. In some cases the β_1 fraction could be subdivided into β_1^1 and β_1^2. Four days after exposure, marked changes could be observed in the electrophoretic pattern of the serum protein fractions. The proportion of albumin decreased and that of α_2-globulin increased. These changes were even more marked at the peak of radiation sickness, with an additional increase in the α_2-fraction. At this time a completely new fraction, the so-called α_4-fraction appeared, which is a sign of the impending death of the animal. In those animals which recovered from radiation sickness, the recovery was preceded by the disappearance of this fraction. The β_1- and β_2-fractions usually showed an initial decrease followed by an increase. It is believed that this increase is connected with an immunological reaction, such as the formation of antibodies against denaturated proteins formed as a consequence of the oxidation of SH-groups. The 10 to 15 fractions, found in the electrophoretic pattern of the soluble liver proteins, could be grouped according to their mobility. Each group corresponded to one of the serum protein fractions. It was found that the changes in these fractions were quite similar to those found in the serum protein fractions but were even more marked. It is concluded that radiation affects the protein synthesis in the liver. (OTS)

30412 STUDY OF THE PROTEIN FRACTIONS IN THE BRAIN AFTER EXPOSURE TO X RAYS. O. M. Narepekha. Prob. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 26-9 (1962).

A study was made of the changes in the water-soluble proteins of the brain in 10 adult rabbits exposed to total-body radiation by means of a dose of 800 r at a rate of 16 r/min. After the exposure, the brain was cleaned of blood, meninges, and blood vessels, and was homogenized with an equal volume of normal saline. The homogenate was frozen by means of liquid nitrogen and left in the deep freeze for 24 hours. The homogenate was then melted, and centrifuged for one hour at 15,000 rpm. The supernatant liquid obtained had a protein content of 1.8 to 2%. To increase this to the concentration of serum protein (7 to 8%), the solution was precipitated with tannin and the protein was liberated from the protein-tannate complex with caffeine. The pH adjusted to 4.7. After ten minutes, the solution was centrifuged, the supernatant liquid was discarded, and the centrifugate washed twice in normal saline and redissolved by the addition of caffeine. The solution was centrifuged for 30 minutes at 15,000 rpm, after which the centrifugate contained the protein liberated from the protein-tannate complex. The solution obtained had a protein concentration of 9 to 10%. This was then investigated by electrophoresis on agar gel in a veronal-medinal buffer (pH 8.6), at a voltage of 220 v. In the control rabbits, electrophoresis of the solution obtained in the described manner yields 9 to 11 fractions, one of which was a prealbumin fraction, the second an albumin fraction, and the others corresponded to various serum-globulin fractions. In rabbits exposed to radiation, the number of fractions increased to 13, mainly fractions corresponding to the serum-albumins. (OTS)

30413 THE INFLUENCE OF RADIATION UPON THE PHOSPHOROUS CONTENT AND ITS METABOLISM IN THE BRAIN. G. V. Aksenova, O. S. Zrada, G. N. Krugovaya, Ya. V. Oleynik, A. K. Starostyuk, L. N. Cherkashchenko, and A. G. Chernogalova. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 30-4(1962).

Frogs were exposed to total-body irradiation of 200 r (at 10 r/min) from a distance of 16 cm. The brains were then investigated 2 hrs, and 2, 5, 7, and 11 days after exposure. Four hours before decapitation, 0.5 ml of aq $NaH_2P^{32}O_4$ of a dosage of 25 μC per 100 g weight, was administered by intraperitoal injection. The amount of acid-soluble P and its metabolism, the phospholipids, and the protein P of the brain were then investigated. Two hours after exposure, the total P-content in the acid-soluble fraction increased by 12.8% as compared with the control animals. The inorganic P-content increased by 11%, the total protein P by 21%, and the content of phospholipids decreased by 23.7%. These changes were even more marked after 2 days, when the total acid-soluble P fraction increased by 27.1%, out of which the inorganic P increased by 31%, the total protein P by 27.8% and the phospholipid content decreased by 42%. Six days after exposure, the total acid-soluble P fractions had increased up to 46.2% and the inorganic P-content by 87%. At the same time, however, the phospholipid content decreased by 23% and the content of protein P by 18%. Seven days after exposure the total acid-soluble P fraction increased by 50% but the total quantity of inorganic phosphate increased by 11.1% compared with the control animals. The phospholipid content was still decreased by 33% and the total protein P by 30%. Eleven days after exposure, the total acid-soluble P fraction was still increased by 45% out of which the inorganic P exceeded the values found in the control animals by 36%, the content of the phospholipids was again increased by 37%, and the content of the total protein P decreased by 39%. Thus the acid-soluble P fraction remained increased throughout the experiment, but the

changes in protein P and phospholipids moved in opposite directions. After an initial increase in the protein P level a decrease could be observed, while the phospholipids showed an increase. Two hours after exposure, the rate of metabolism, as estimated by the relative specific activity of the fractions, showed changes parallel to those in the P content. After 2 to 5 days, the decrease of the specific activity in all fractions indicated a slowing down of the phosphate metabolism which reverted to its normal level after 9 to 12 days. (OTS)

30414 CHANGES IN SOME PHYSIOLOGICAL INDICES IN GUINEA-PIGS SUFFERING FROM ACUTE RADIATION SICKNESS. L. G. Kovtunovich. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 43-57(1962).

Guinea pigs were exposed to total-body radiation with x rays at a rate of 33.9 to 58.8 r/min from a distance of 40 to 50 cm in a lethal dose of 500 r, sublethal dose of 100 r, and an intermediate dose of 300 r. After the exposure, the changes in the white cell count and in the hemoglobin level were followed up until the animal died. The findings obtained on the same animals before exposures served as control level. The guinea pigs' symptoms of radiation sickness and the autopsy findings were also recorded. In some experiments the guinea pigs were exposed a second time to total-body radiation, 2.5 to 5 months after the first exposure. A dose of 100 r caused a nonlethal radiation sickness which was accompanied by a moderate anemia and leucopenia. A dose of 500 r caused the death of 77.5% of the animals and the radiation sickness was accompanied by marked anemia and leucopenia. The survival of some of the animal suggests the existence of individual differences in the resistance to radiation. Females proved to be less resistant to radiation than males: for example, after exposure to 500 r, marked leucopenia occurred in ½ of the females and only ⅓ of the males, very low hemoglobin levels (20 to 30%) were found in 8 out of 22 females and 11 out of 67 males, and the radiation sickness led to the animals' death in 20 out of 22 females and only in 49 out of 89 males. If surviving animals were exposed a second time, they appeared to have an increased resistance to lethal doses. Immunization with Clostridium perfringens did not aggravate the course of radiation sickness. (OTS)

30415 THE INFLUENCE OF ASCORBIC ACID UPON THE COURSE OF RADIATION SICKNESS IN WHITE RATS. V. M. Pobegaylo, V. F. Podusovskii, and B. T. Glukhenkii. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 59-63 (1962).

Studies were made of the clinical picture and morphological changes in the internal organs of 62–200 to 250 g white rats exposed to radiation emitted by P^{32}, administered by intraperitoneal injection, and treated with ascorbic acid. Of these, 32 rats were given a dose of 1.5 μC. In this group, 16 rats received no further treatment and served as control animals, and 16 rats were given 1.0 ml of a 5% ascorbic acid solution daily by intramuscular injection, until the animal died. The remaining 30 rats were given a dose of 2.5 μC. Here, too, 15 rats received no further treatment and served as control animals, and 15 rats were given ascorbic acid. After each animal's death (occurring at different times), the brain, lymph nodes, and all internal organs were investigated. In the control animals exposed to the smaller dose of 1.5 μC, a period of excitation lasting 8 to 10 hours was followed by apathy, pyrexia, and loss of weight. After a period of apparent recovery, the animals' condition deteriorated again after 15 to 25 days. Fifty per cent of these animals perished of multiple hemorrhages in the mucous membranes, the serous membranes and all internal organs, showing loss of hair and ulceration of the skin. The rats slowly recovered. In the group exposed to the larger dose, all control animals perished within 21 days. During the first 20 days of treatment with ascorbic acid, no difference could be found between the experimental and the control animals, exposed to the smaller dose. Later, however, the clinical symptoms were much less marked, with all animals living longer and the greater proportion surviving. The experimental animals exposed to the larger dose perished without exception, but only after 48 days. In the control groups, autopsy revealed multiple hemorrhages in all internal organs and on the mucous membranes, parenchymatous degeneration and necrosis, the latter particularly in animals exposed to the larger dose. The regenerative changes in the shape of the cell proliferation round the necrotic foci were insignificant. In the group treated with ascorbic acid, the degenerative changes and the hemorrhages were less marked and active cell proliferation could be observed round the foci of destruction. (OTS)

30416 THE RADIOSENSITIVITY OF BIRDS. V. A. Kushnuruk. Probl. Lab. Radiobiol., L'vovsk. Gos. Univ., No. 1, 81-3(1962).

Earlier reports suggest that the radiosensitivity of birds varies according to the systematic position of the species in question. To study this question in greater detail, birds belonging to different species were exposed to x rays and the LD_{50} for 30 days recorded. During exposure, the birds were kept in a small cage but could move freely. Five different species were investigated: the greenfinch (Chloris chloris L.), goldfinch (Carduelis carduelis L.), linnet (Acantis cannabina L.), house sparrow (Passer domesticus), and the canary (Serinus canarina L.). It appeared that the radiosensitivity of the birds moved within a fairly narrow range quite independently of the species. The LD_{50} for 30 days varied in the 5 species in question between 400 and 625 r. All birds showed disorders of the coordination of movements, in the reflex governing the picking of food, in flight, and in perching. (OTS)

30417 EFFECTIVENESS OF THE HIGH-MOLECULAR DNA IN THE TREATMENT OF ACUTE RADIATION SICKNESS. R. E. Libinzon. V. V. Konstantinova, K. N. Muksinova, T. G. Popova, and S. A. Rogacheva. Radiobiologiya, 3: 111-16(1963). (In Russian)

Although the therapeutic action of the bone marrow in the treatment of irradiated animals is mostly due to the repopulation of the donor's cells in the body of the recipient, it is possible that the decomposition products of the introduced cells stimulate the blood formation. It was noted that during the first days after the introduction of the bone marrow suspensions, a stimulating action was exerted on the reticular cells of the recipient's bone marrow. This effect might be due to desoxynucleoproteid or to DNA of the animal's bone marrow cells, the therapeutic effect of DNA introduced into various tissues of animals affected by radiation sickness was investigated. Rats of both sexes were exposed to 1000 r of γ radiation of Co^{60} at a dose rate of 20 r/min, administering within 24 hours after the exposure 3 to 6 mg of specially prepared, high-molecular DNA in 1 to 2 ml of physiological solution intravenously or intraperitoneally; unirradiated but injected animals served as controls. Results indicated that the isologous, high-molecular preparation had a high therapeutic effectiveness. The survival rate jumped from 2 to 13% level in the control group to 40 to 58%. Factors affecting the DNA preparation reduced its effectiveness. The

effect is probably due to the phagocytosis of the DNA particles and of the desoxyribonucleoproteid by the reticular cells of the blood. (TTT)

30418 THE INFLUENCE OF UREA PEROXIDE ON THE POST-IRRADIATION RECOVERY OF INFUSORIA. A. S. Popov. Radiobiologiya, 3: 121-5(1963). (In Russian)

In view of the previously reported effect of urea peroxide on the mechanism of radiation injury, the contribution of this compound, considered as a representative of organic peroxides, to the post-irradiation recovery of cells was investigated. Paramecium caudatum cultures, kept in darkness at 21°C were exposed to the γ radiation of a Co^{60} source at a dose rate of 248 to 275 r/sec to a total dose of 200 kr under addition of 1×10^{-3} and 6×10^{-3} M urea peroxide solutions. It was found that 5 days after the treatment with the urea peroxide solution, the control specimens exhibited a constant rate of fission, regardless of the concentration of the solution. The fission rate of the cultures irradiated in urea peroxide did not differ from that of another control series, irradiated under water. It is concluded that the urea peroxide does not affect the postirradiation recovery of the cells. It was assumed that the ionizing radiation and the organic peroxide act on the same substratum of the cells; however, the results showed that exposure to radiation causes considerably wider range of injuries of the substratum than the organic peroxides. (TTT)

30419 PROTECTION OF ANIMALS AGAINST γ-RADIATION BY MEANS OF CERTAIN AMINOPHENON. E. F. Romantsev and M. V. Tikhomirova. Radiobiologiya, 3: 126-9(1963). (In Russian)

Several aminophenons were tested for determining their usefulness as protective chemical media against ionizing radiation. Male white rats and dogs were used for the tests, irradiating the former by x rays at a dose rate of 34 r/min to a total dose of 650 r which resulted in the death of 95 to 100% of the unprotected control animals. Similar experiments were also carried with a Co^{60} γ source at a rate of 334 r/min for a total dose of 750 r ($LD_{95-100/30}$). The dogs were exposed to a lethal dose of 350 r. The compounds were introduced into the animals intraperitoneally or orally in propylene glycol solution. The results showed that p-amino acetophenone, p-amino-propiophenone, and p-amino-butyrophenone markedly increase the survival rate of rats exposed to a $LD_{95/30}$ dose. Oral introduction of p-aminopropiophenone, used in connection with subsequent administration of antibiotics and vitamins increased the survival rate of dogs and reduced the gravity of radiation sickness. Substitution of H in the amine group by 2 methyl groups reduced the prophylactic effect of p-amino-propiophenone from 70 to 40%. Similar substitution used simultaneously with the substitution of keto groups by OH deprived the compound from its radioprotective action; substitution of NH_2 by OH had a similar effect. (TTT)

30420 THE EFFECT OF IONIZING RADIATION ON THE OXYGEN-CARRYING CAPACITY OF BLOOD IN RABBITS IRRADIATED WITH A LETHAL X-RAY DOSE. I. V. Vysochina (Inst. of Biological Physics, Academy of Sciences, Moscow). Radiobiologiya, 3: 204-10(1963). (In Russian)

Rabbits 3.0 to 3.5 kg in weight were given a lethal x-ray dose of 900 to 1300 r. The dissociation of oxyhemoglobin in the blood was determined by Van Slyke's apparatus before and after the irradiation. In addition, the hemoglobin content, the pH of the blood, and the number of erythrocytes and leucocytes were also determined before and after the irradiation. After it was found that the content of oxygen and carbon dioxide in the blood falls rapidly in the first moments of irradiation and that the arterial-venous difference in oxygen increases by a factor of two or more as compared to the initial state, the oxygen and CO_2 carrying capacity of the irradiated rabbits was determined. It was found that the radiosensitive rabbits undergo a sharp drop in the oxygen capacity of the blood (almost a factor of two), and die a few days after the irradiation. The oxygen capacity of the blood of the radioresistant rabbits does not change immediately after the irradiation, but decreases by 15 to 30% about 3 weeks after the irradiation. The capacity of hemoglobin for oxygen decreases drastically with time. (TTT)

30421 THE RECOVERY OF HEMATOPOIESIS IN DOGS SURVIVING THE ACUTE RADIATION SYNDROME. E. N. Antipenko (Kirov Academy of War Medicine, Leningrad). Radiobiologiya, 3: 211-15(1963). (In Russian)

Dogs were given a Co^{60} dose of 400 r ($LD_{50/30}$) and 650 r ($LD_{90/30}$). After irradiation with a 650 r dose, part of the dogs were treated with antibiotics, vitamins and blood transfusions. This treatment increased the survivial by 60%. The leukocytes, neutrophils, lymphocytes, erythrocytes, thrombocytes, and hemoglobin content were determined for periods of up to 3 years after the irradiation. With a 400 r dose, the neutrophil count attained 90% of its initial values between 6 and 10 months after the irradiation, but the lymphocyte count was a factor of two less than it was before the irradiation. The ratio of myeloid cells to erythroid cells was lower in the bone marrow of the irradiated animals than in the controls 3 years after the irradiation, although the number of neutrophils and erythrocytes in the peripheral blood was found to be normal. About a year is required to establish normal granulopoiesis and thrombopoiesis in the irradiated dogs, but normal lymphopoiesis was not observed in a single animal even three years after the irradiation. Normal leucopoiesis was established more rapidly in dogs given therapeutic treatment than in the untreated dogs. (TTT)

30422 THE SIGNIFICANCE OF SENSITIZATION BY TISSUE ANTIGENS IN REACTIVITY CHANGES OF AN IRRADIATED ORGANISM. EXPERIMENTAL HOMOSENSITIZATION AND ITS EFFECT ON IMMUNOGENESIS. N. N. Klemparskaya and V. V. Shikhodyrov. Radiobiologiya, 3: 230-9(1963). (In Russian)

Homosensitization can be induced in a healthy animal by injecting a suspension of tissue taken from an irradiated animal. Pathological symptoms characteristic of radiation sickness such as internal bleeding and changes in tissue penetrability can lead to the death of the animal two or three weeks after sensitization. Due to the competition between antigens, the introduction of a bacterial antigen after sensitization results in a decrease in severity of the pathological symptoms. Thus, experiments on rabbits show that the introduction of a microbial antigen during the first week after sensitization by irradiated tissue can decrease the severity of pathological symptoms such as a loss in weight and the development of leucocytosis. Experiments on guinea pigs gave similar results. In this case, inoculation with the bacterial antigen 15 days after sensitization resulted in a decrease of the number of cases of leucopenia by a factor of 7, as compared to the sensitized guinea pigs which were not treated with a bacterial antigen. A histological study of tissue from sensitized white mice shows the presence of protein dystrophy of the parenchymal cells, an increase in the number

of Kupffer cells, a decrease in the number of lymphocytes, bleeding in lung tissue, and edema of the alveolar membrane. The best results in mitigating the pathological symptoms of sensitization in white mice were obtained by inoculating the mice with the microbial vaccine before sensitization. (TTT)

30423 THE YEAST CELL MODEL AS A METHOD OF ESTIMATING THE RADIOPROTECTIVE PROPERTIES OF CHEMICAL COMPOUNDS. D. V. Mangina. Radiobiologiya, 3: 240-6(1963). (In Russian)

Since experiments with white mice are lengthy and costly, the suitability of yeast cells Saccharomyces vini of the strain Megri 139B was investigated as a substitute for white mice in evaluating the radioprotective properties of 47 chemical compounds containing various combinations of amino and sulfur groups. An aqueous suspension of yeast cells was added to the solution of the chemical compound to give about 1.5×10^5 cells per ml. The yeast cells were subjected to x-ray doses of 30, 45, and 60 kr. The survival of LD_{50} dose was obtained, and the results were compared with those obtained from experiments on white mice. A total of 15 out of 47 compounds showed protective properties in the yeast experiments, and 13 of these 15 compounds were also effective in protecting white mice. It is concluded that microorganisms, especially yeast cells, are a suitable means of screening chemical compounds for radioprotective properties. The disadvantage of the method is that only water-soluble compounds can be tested with yeast cells. (TTT)

30424 DETAILS OF THE CHANGE IN EFFECTIVENESS OF A NUMBER OF PROTECTIVE SUBSTANCES WITH VARYING IRRADIATION DOSE. V. I. Suslikov (Inst. of Biological Physics, Academy of Sciences, Moscow). Radiobiologiya, 3: 247-55(1963). (In Russian)

The fraction of individuals surviving due to the use of a protective substance as compared to the total number dying in a control group can be expressed as a prabability factor: $\alpha = \alpha(D,A) = [M(D) - M(D,A)]/M(D)$. Here M(D) is the number of deaths after irradiation with a dose D (control), and M(D,A) is the number of deaths after irradiation with the same dose D, but with the use of a protective factor A (experimental). The probability of survival of an animal which would have died in the absence of protection was plotted as a function of increasing dose for a number of protective substances. The protective factors can be divided into two groups. In one group, there is a monotonic decrease in the survival probability for such protective measures such as the use of morphine in mice and the use of hypoxia in E. coli. In the other group which involve the use of protective substances such as glutathione, β-mercaptoethylamine, diethylstilbestrol, 3-amino-1,2,4-triazol, cysteine, and shielding of the spleen, an increase in protective efficiency with increasing dose is observed up to a certain limiting value with a subsequent decrease in protection with a further increase in dose. The maximum survival probability occurs within the limits of 350 to 850 r for various protective measures. It is shown by a mathematical analysis that the effectiveness of a number of protective substances is due to the protection of recovery mechanisms in warm-blooded animals. This recovery mechanism is different from that operating at the cell level. (TTT)

30425 THE PROPHYLAXIS OF RADIATION SICKNESS IN MONKEYS BY MEANS OF 5-METHOXYTRYPTAMINE. I. G. Krasnykh, P. G. Zherebchenko, L. F. Semenov, N. N. Suvorov, and K. A. Zeitunyan. Radiobiologiya, 3: 259-61 (1963). (In Russian)

Severe radiation sickness was induced in monkeys by administering a gamma dose of 607 r. The radioprotective agent 5-methoxytryptamine was administered orally at a dosage of 250 mg/kg 30 minutes before the irradiation, and intramuscularly at a dosage of 25 mg/kg 10 minutes before the irradiation. All the controls died within 30 days with an average life of 9.2 days after showing severe symptoms of radiation sickness. The average life span was 17.3 days for the monkeys given intramuscular injection of the protective agent, and one out of seven monkeys was still living 30 days after the irradiation. Another monkey perished on the 30th day. Three out of eight monkeys, which had been given oral dose of the protective agent, were living on the 30th day after the irradiation. The average life-time was 14.0 days for this group. The appearance of bleeding, and the severity of leucopenia were less in the groups given a protective agent than they were in the controls. The protective agent 5-methoxytryptamine is more effective than tryptamine as a radioprotective agent. (TTT)

30426 THE RADIOPROTECTION OF THYMOCYTES IN RATS BY MEANS OF INDOLE DERIVATIVES. G. M. Airapetyan. Radiobiologiya, 3: 262-4(1963). (In Russian)

The compounds 5-methoxytryptamine, which show good radioprotective properties in mice, 6-methoxytryptamine, which is a poor radioprotective agent, and δ-3-indolylbutylamine, which has no effect on the outcome of radiation sickness in mice, were used to study the radioprotective properties of amines of the indole series under in vitro conditions. Dead thymocytes are stained by eosin and are used to follow the radioprotective properties of the indole compounds. A suspension of thymocytes in a Ringer solution was isolated from the thymus of young, decapitated rats, and was given an x-ray dose of 1300 r. The percent survival of the cells was calculated with respect to the unirradiated control. The compounds 5- and 6-methoxytryptamine gave a cell survival of about 87% and 75% when added to the thymocyte suspension in concentrations of 1:4000 and 1:40,000, respectively. Without addition of the radioprotective agent, the cell survivals were 63 and 67%, respectively. The compound δ-3-indolylbutylamine was toxic at a concentration of 1:4000, and gave a cell survival of 17.5% with addition of reagent, and 67.9% without addition of the reagent. However, at a concentration of 1:40,000 this compound showed radioprotective properties. The cell survival was 80.3% with addition of the reagent and 66.7% without addition of the reagent. The protective effect for all three is the same in vitro, and cannot be correlated with the protective effect of these compounds in vivo. (TTT)

30427 THE RADIOPROTECTION OF THE HEMATOPOIETIC ORGANS OF MICE BY MEANS OF A NUMBER OF CHEMICAL COMPOUNDS. N. P. Lebkova and A. N. Shevchenko. Radiobiologiya, 3: 265-9(1963). (In Russian)

White mice were given an x-ray dose of 700 r ten minutes after injection with a radioprotective compound. The mice were killed 4 hours after the irradiation, and the number of degenerate cells per 3 to 5 thousand healthy cells was determined. The protective effect on the hematopoietic organs can be correlated with the survival data available for these compounds. Thus, 5-methoxytryptamine was more effective than mercamine and tryptamine in protecting the hematopoietic organs of the mice, and γ-3-indolylpropylamine and δ-indolylbutylamine showed very little protective effect. A combination of mercamine and 5-methoxytryptamine was more effective than a combination of mercamine and tryptamine. The introduction of α-methyltryptamine, which is an inhibitor of mono-

amineoxidase, an hour before irradiation has an adverse effect on the protective action of 5-methoxytryptamine. All the radioprotective compounds noticeably decrease the destruction of cells in the hematopoietic organs, and there is a definite correlation between the magnitude of the decrease in cell destruction and the effect of the radioprotective compound on the survival of irradiated animals. Experiments with mercamine at an irradiation dose of 200 r showed that the optimal protective dosage of 150 mg/kg of the compound was more effective in decreasing the number of degenerate cells and chromosomal aberrations than a lower dosage of 75 mg/kg of mercamine. (TTT)

30428 THE PROTECTIVE EFFECT OF POLYANIONS IN THE IRRADIATION OF MICE WITH A LETHAL DOSE OF X-RAYS. S. V. Argutinskaya and R. I. Salganik (Inst. of Cytology and Genetics, Novosibirsk, USSR). Radiobiologiya, 3: 276-80(1963). (In Russian)

The polyanions inhibit the denaturization of DNA. Thus, it is possible that these compounds may possess radioprotective properties. Mice were given a lethal x-ray dose of 750 to 800 r after injection with hyaluronic acid (50 mg/100 g), RNA (50 mg/100 g), heparin (75 mg/100 g), and the synthetic polymers polyphenylphosphate and polyxenylphosphate (25 mg/100 g). The survival at 30 days increased to 37.9% (11.5% in the controls) with hyaluronic acid, 41.7% (28.6% in the controls) with heparin, and 48.2% (7.5% in the controls) with cysteine which was used as a comparison standard. Preliminary results with polyxenylphosphate showed that only one out of four mice died up to the 30th day, while all ten control mice perished. With polyphenylphosphate 6 out of 8 mice survived, while only 3 of 8 survived in the control group. With the use of cysteine and a polyanion, the survival increased to 42.1% as compared to a survival of 38.5% with the use of cysteine alone. These substances all differ chemically and structurally, but they all show a definite radioprotective effect, probably due to their ability to prevent denaturization of DNA. (TTT)

30429 A QUANTITATIVE EVALUATION OF THE PROTECTIVE EFFECT OF IMIDAZOLE DERIVATIVES AS A FUNCTION OF IRRADIATION DOSE. A. M. Stashkov and V. P. Korotkova (Inst. of Experimental Medicine, Academy of Medical Sciences, Leningrad). Radiobiologiya, 3: 281-5(1963). (In Russian)

The prophylactic effect of diamine imidazoledicarboxylic acid (antiphene), and the ethyl- and allylnor-antiphene derivatives was studied over an x-ray dose range of 500 to 1000 r. The data show that these substances are the most effective when the white rats are given a dose of 800 r. Antiphene increases the survival by 36%, ethylnorantiphene by 33%, and allynorantiphene by 55% as compared to the controls. The results were analogous at a dose of 700 r. On increasing the dose to 1000 r or decreasing to 500 r, the difference in survival between the experimental and control animals becomes insignificant. The protective activity of these compounds increases with increasing irradiation dose up to a certain optimum level, and then decreases with a further increase in radiation dose. (TTT)

30430 THE EFFECT OF VARIOUS TYPES AND DOSES OF IRRADIATION ON THE CATALASE AND PEROXIDASE ACTIVITY OF THE BLOOD OF RABBITS. M. A. Darakhvelidze. Soobshch. Akad. Nauk Gruz., 28: 33-9 (1962).

The medical literature refers to the liver catalase activity following x-ray irradiation of rats but the data have not been related to the severity of the radiation sickness. Sixty-seven rabbits weighing 2.0 to 2.7 kg were irradiated with 400, 600, and 1200 rads from a PYM-3 (RUM) unit, at 12 r/min. The equivalent internal doses administered orally as a dibasic salt solution of P^{32} were 1.2, 1.88, and 3.8 μcuries/g, respectively. A combined irradiation was performed by administration of P^{32} immediately after external irradiation with half the dose. Catalase was determined manganometrically, and peroxidase with pyrogallol. The catalase activity in the blood decreased independently of the irradiation dose. Peroxidase turned out to be more resistant to irradiation, and its activity decreased only after a dose of 1200 rads. Internal irradiation affected the enzymes more severely than external irradiation. The determination of catalase activity together with examination of WBC may be of prognostic value if performed soon after irradiation as well as after the acute stage of radiation sickness. (OTS)

30431 STRUCTURAL CHANGES CAUSED BY γ-RADIATION IN THE LYMPHOID TISSUE OF EXPERIMENTAL ANIMALS MAINTAINED ON DIFFERENT DIETS. V. K. Demidova. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 9-20(1962).

Adult male white rats (162 animals each weighing 187 to 350 g) and 47 young male rats (weighing 80 to 220 g) were exposed to total-body γ-irradiation, using the GUT Co-400-1 apparatus. The young rats (previously kept for 4 weeks on wheat biscuits) were then divided into 2 groups. In the first group 2 g and in the second group 6 g of a protein vitamin complex were added to each daily food ration. After 4 weeks on this diet these young animals were then exposed to 500 r. The adult rats were kept for 4 weeks on the usual laboratory diet and were also divided into 2 groups; the first group was kept on wheat biscuits alone for 4 weeks, and the second on biscuits containing 35% of a protein-vitamin complex. After 4 weeks on this diet the adult rats were exposed to 700 r. Both young and adult animals were killed 36 hours, 5, 10, 20, and 50 days after exposure. Paraffin sections of the lymphoid tissue in the lymph nodes, the spleen, the thymus, and the liver were stained with hematoxylin and eosin, and by van Gieson's and Maximov's stains. In the spleen, the lymph nodes, and the thymus, a marked decrease in the number of lymphocytes could be observed within 36 hr after exposure. No mitoses could be seen and the nuclei occasionally showed signs of fragmentation. Hyperplasia of the reticular apparatus developed. Severity of the lesions showed no relation to the diet. In animals kept on a deficient diet, however, the onset of regeneration was delayed. In the liver, however, the picture was different. Here the initial lesions were more profound in animals kept on a deficient diet, whereas the rate of regeneration was the same in both groups. (OTS)

30432 NERVOUS ELEMENTS IN THE WALL OF THE STOMACH IN NORMAL RATS AND IN RATS SUFFERING FROM RADIATION SICKNESS. N. N. Zhuravlev. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 21-30(1962).

One hundred and ten white rats were exposed to a sublethal dose of radiation (700 r) emitted by the GUT Co-400-1 apparatus. One hundred and twenty-two rats were not exposed to radiation and served as the control group. Both the experimental and the control group were further divided into two subgroups, one of which was kept on wheat biscuits containing a protein-vitamin complex, considered to be an adequate diet, and the other on wheat biscuits alone, a diet considered to be deficient in proteins and vitamins. The animals were killed 36 hours, 5, 10, 20, and 50 days after exposure to radiation. The stomach was

fixed in neutral formalin and the intramural nervous apparatus of the stomach was impregnated with silver by the method of Bielschovskiy and Gross. The ganglion cells and the nerve fibers proved to be more vulnerable than the sensory nerve endings. The ganglion cells showed an increased uptake of silver, with changes in shape and size. Some cells showed vacuolization or underwent complete disintegration. The nerve fibers also showed an increased uptake of silver, with vacuolization of the axis cylinders and varicous thickenings, and some fibers even disintegrated completely. Changes in the sensory nerve endings were only slight, consisting of an increased uptake of silver and swelling confined to short stretches of some of the terminal processes. No relation between the described changes and the diet could be established. (OTS)

30433 CHANGES OCCURRING IN THE NUMBER OF MAST CELLS AND EOSINOPHILS OF THE SKIN, MESENTERY AND OMENTUM IN WHITE RATS SUFFERING FROM RADIATION SICKNESS AND KEPT ON DIFFERENT DIETS. V. K. Rudzit. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 31-9(1962).

One hundred eighty-nine rats were kept for 21 days on an improved diet consisting of milk, meat, yeast, various cereals, brown bread, and vegetables; 20 control rats were kept on the standard laboratory diet. After 3 weeks, 21 rats among those kept on the improved diet were killed and investigated. Eighty-four more rats of the same group were kept on a diet of wheat biscuits containing 25% of a protein-vitamin complex and the remaining 84 rats were kept on wheat biscuits alone, i.e., on a diet deficient in proteins and vitamins. After 30 days, 14 rats in each group were killed and investigated. Forty-four rats of each group were exposed to total-body radiation with gamma rays (700 r) emitted by the GUT Co-400-1 apparatus; 26 rats in each group were not exposed to radiation. More experimental animals from each group were killed on the 2nd, 5th, 10th, 20th, and 50th day after exposure to radiation. The mesentery and the omentum of all the killed rats were fixed with methyl alcohol and stained with Romanowsky's stain. Paraffin sections of the skin were stained by the same method. It was found that in animals kept on an improved diet, the number of mast cells increased above the control normal. In animals kept on a diet relatively deficient in proteins and vitamins, the number of mast cells was decreased. Gamma radiation caused a decrease in the number of mast cells in both groups; this was more marked in animals kept on a deficient diet. The number of eosinophils in the omentum increased after exposure to radiation, to an extent independent of the diet. (OTS)

30434 THE INFLUENCE OF γ-RADIATION UPON HEMOPOIESIS IN WHITE RATS KEPT ON DIFFERENT DIETS. L. Yu. Prane. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 41-62(1962).

One hundred and eighty-nine adult male rats were employed for these tests, 21 animals being used as controls, to establish the initial condition of the hemopoietic system. The remaining 168 rats were divided into two equal groups, one of which was kept on wheat biscuits to which a protein-vitamin complex had been added (a balanced diet), and the other on a diet of wheat biscuits (regarded as deficient in proteins and vitamins). One month later, 14 rats in each group were killed and investigated, with the remainder of each group being divided into two subgroups. Here 40 rats in each group were γ-irradiated with doses of 700 r, emitted by the GUT Co-400-1 apparatus. Thirty rats of these subgroups were not exposed to radiation. In all animals, the red cell count, the hemoglobin level, the number of reticulocytes, the color index and the packed cell volume, the erythrocyte sedimentation rate, the platelet and white cell counts, and the differential count of the blood were investigated. Myelograms of the bone marrow were also prepared. The results are evaluated statistically, concluding that the destructive and degenerative changes observed in the blood after irradiation were independent of the diet. The regeneration of functioning hemopoietic tissue was however much slower in animals kept on the restricted diet deficient in proteins and vitamins. (OTS)

30435 MORPHOLOGICAL CHANGES IN THE BLOOD AND BONE MARROW OF WHITE RATS OF DIFFERENT AGES, EXPOSED TO SUBLETHAL DOSES OF γ-RADIATION (IN ANIMALS KEPT ON DIFFERENT DIETS). L. Yu. Prane. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 63-78(1962).

Young rats (37 animals weighing 82 to 90 g each) and 113 adult or ageing rats (weighing 187 to 350 g each) were used for the experiment. After an investigation of 24 animals in each group to establish the initial condition of the peripheral blood and the bone marrow, one half of each group was kept on an adequate diet and the other half on a diet deficient in proteins and vitamins. After a preliminary period of 1 to 2 months the animals were exposed to γ radiation in a dose of 700 r, emitted by the GUT Co-400-1 apparatus. The animals were killed 36 hours, 5, 10, and 20 days after exposure. The peripheral blood and the myelogram were then investigated. In both young and adult (ageing) animals, blood changes characteristic of acute radiation sickness could be observed. In young animals kept on an adequate diet, however, these changes were less marked than in young animals kept on a deficient diet. No such difference could be found between the two groups of adult rats kept on different diets. A diet deficient in proteins and vitamins delayed the regeneration of the blood picture in both age groups. Here too, however, the young animals seemed to recover more rapidly on an adequate diet. These differences are explained by the greater reactivity of young animals. (OTS)

30436 BIOCHEMICAL DISORDERS CAUSED BY IONIZING RADIATION IN ANIMALS, WITH REGARD TO THE STATE OF NUTRITION OF THE LATTER. A. A. Shmidt. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 79-82(1962).

One group of rats was kept on a normal diet, while another was given a diet of wheat biscuits, considered to be deficient in proteins and vitamins. In each of the 2 groups some animals were exposed to total-body irradiation, with 700 r dose of γ rays, emitted by the Гγт Co-400-1 (GUT Co-400-1) apparatus, while the remainder served as a control group. The organ weight in relation to the body weight and the weight of the dry residue of the liver, lungs, kidneys, and the skin were estimated in all animals, as well as the choline content of the organs. In animals kept on a normal diet, the relative weight of the lungs increased after exposure to radiation, beginning on the 20th day, whereas in animals kept on a deficient diet the weight of the lungs showed a continuous decrease starting from the first day after exposure. The choline content of the liver, as estimated by the method of Acker and Ernst, increased in all animals independently of the diet. The choline content of the lungs increased in rats maintained on the full diet. In the other organs, radiation exerted no influence upon the choline content. The thiamine content of the liver (initially high in animals on an adequate diet) decreased after irradiation, whereas the initially low thiamine content of the liver of animals on a deficiency

diet showed a slight increase. γ radiation had no appreciable effect upon the content of riboflavine and vitamin B_{12}. The content of ascorbic acid of the liver and the adrenal glands increased after exposure to radiation, independently of the diet. An increase in the globin content of the blood could be observed only in animals kept on a full diet. In these animals, iron accumulated to a greater degree in the spleen and the bone marrow. As a whole, this investigation showed that biochemical changes are more marked in animals kept on a full diet, a fact which is explained by the greater activity of the biochemical processes. (OTS)

30437 THE INFLUENCE OF IONIZING RADIATION ON CAROTENE METABOLISM AND ON THE FORMATION OF VITAMIN A IN RATS. A. A. Nozhenko. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 135-9(1962).

Eighty-eight adult male white rats were divided into 2 equal groups, one of which was exposed to a single γ dose of 700 r, emitted by the GUT Co-400-1 apparatus, while the other group served as a control. Feces of the experimental animals were collected. On the 5th, 20th, and 50th days after exposure, the animals were decapitated and investigated. The carotene metabolism was assessed by comparison of the contents in the daily ration, in the feces, and in the liver. 20 days after exposure, the utilization of carotene, expressed as percent of the carotene content in the daily ration resorbed by the intestine, was found to be decreased. The carotene content was assessed by a method developed in the All-Union Scientific Research Vitamin Institute. At the same time, the vitamin A content in the liver, as estimated photocolorimetrically by the method of Carr and Price, showed a significant increase. This apparent contradiction is explained by the assumption that radiation impairs the resorption of carotene from the intestine to a greater degree than the synthesis in the liver, which might even be increased to meet the greater demands placed on it by irradiation. (OTS)

30438 THE INFLUENCE OF IONIZING RADIATION ON THE BLOOD PROTEINS OF RATS. G. D. Solazemnietse. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 141-58(1962).

One hundred and fifty-six male white rats each weighing 300 to 350 g were used. One group of animals was kept for 3 to 4 weeks on a normal laboratory diet, a second group on wheat biscuits enriched with a protein-vitamin complex, and a third group was fed wheat biscuits (representing a deficient diet). In a preparatory period prior to irradiation, it could be established that a diet of wheat biscuits enriched with a protein-vitamin complex did not influence the chemical composition of the blood, the liver, or the spleen. In animals kept on wheat biscuits alone, however, the iron content of the blood decreased by 4.8% and the globin content decreased by 10.3%. In these animals the globin contained a higher proportion of tryptophan (+4%). Radiation caused a significant decrease in the globin content. The relatively higher proportion of tryptophan within the globin content in the blood of the latter group became even more marked. The blood iron level showed no significant changes. (OTS)

30439 A RATIONAL DIET FOR PATIENTS WITH MALIGNANT DISEASE AND RECEIVING RADIOTHERAPY. K. A. Skulme. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 171-244(1962).

Two-hundred-ninety patients with malignant disease, mainly women suffering from carcinoma of the cervix (aged between 41 and 60), received deep x-ray therapy in a single dose of 250 to 300 r twice daily up to a total of 18,000 r, or one local treatment with Co^{60} in a single dose of 1800 to 2600 mg/hr up to a total of 8000 to 12,000 mg/hr for 30 to 60 days. The patients were assessed every 5 to 10 days with regard to their general condition, hemopoietic function, protein and vitamin metabolism, and the secretory and motor functions of the stomach. The patients were divided into 4 groups, the first of which (66) was given the usual hospital diet. The second group of 67 received a diet enriched with proteins and vitamin C, the third (of 54) was given in addition vitamins B′, B_2, B_6, and PP. Finally, the 4th group of 32 patients received all these and also pantothenic acid, folic acid, and rutin. An earlier investigation showed that the usual hospital diet with an average protein ration of 1 g/kg daily was insufficient to maintain the nitrogen balance of patients with malignant disease and receiving radiotherapy. Experiments were carried out on rats and guinea pigs. General digestive and nervous disorders were observed most frequently, in the 1st and least frequently in the 4th group. Renal disorders, hemorrhages, and a reduction in blood pressure occurred in all 4 groups. The immediate results of the treatment were most satisfactory in the 4th group. The state of the protein reserve was investigated in 172 patients by estimation of the whole blood globin level and the total serum proteins. Radiotherapy caused a marked decrease in the blood globin and serum protein levels, most often in the 1st and least of all in the 4th group. A fall in the globin level could also be produced experimentally in rats exposed to total-body radiation. Radiation also decreased the vitamin C level in the adrenal cortex and blood. This fall could only be observed in patients receiving the ordinary hospital diet but in the other 3 groups it was compensated by the high doses of vitamin C which these groups received. As a rule, radiotherapy led to a decrease in the gastric acid secretion but in some hyperacid patients increased gastric secretion could be observed. These disorders of secretory function were most marked in the 1st group and least marked in the 4th group. Changes in the ammonia and lactic acid contents of the gastric juices were less pronounced. The motor function of the stomach was impaired most in the 1st group and least in the 4th group. The same applied to the loss of appetite and dyspepsia. It is concluded that patients with malignant disease require in the period of radiotherapy a diet reinforced by proteins and vitamins. (OTS)

30440 THE INFLUENCE OF γ RADIATION EMITTED BY Co^{60} UPON THE HEALING OF BONE FRACTURE. R. P. Gerke. Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR, 28: 245-54(1962).

Experimental fractures of a standard size and location were produced mechanically in the radius of rabbits. The animals were then exposed to γ radiation in doses between 10 and 300 r. The time interval between the fracture and the subsequent irradiation varied between 1 and 30 days in the case of animals exposed to small doses and between 1 and 11 days in the other groups. Small doses under 100 r in 28 rabbits exerted no influence upon the healing of the fractures. Medium doses of 100 to 150 r in 19 rabbits delayed the callus formation and sometimes led to deformation and asymmetric healing of the fracture. Large doses of 300 r in 17 rabbits delayed or prevented the callus formation and particularly the calcification. (OTS)

30441 CHANGES IN FUNCTION AND MORPHOLOGY IN A NUMBER OF ORGANS AND SYSTEMS OF MAN AND ANIMALS UNDER THE INFLUENCE OF LARGE AND

SMALL DOSES OF IONIZING RADIATION. V. A. Fanardzhyan, K. A. Kyandaryan, A. G. Beglaryan, S. A. Papoyan, and R. K. Arutyunyan. Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 19-33(1960).

The effects of ionizing radiation on the nervous, circulatory, and digestive systems were clinically and experimentally investigated. (1) Nervous system. Electroencephalography carried out on 20 patients who were irradiated to the head in doses of 4000 to 7000 r for the treatment of malignant conditions of the scalp showed the presence of delta waves of 0.4 to 0.8 sec duration, reduction in the amplitude of the biopotentials, asymmetry of the hemispheres, and occasionally respiratory and cardiac rhythms. These changes were most marked 24 hours after irradiation and had partly returned to normal after 10 days. Thirty persons suffering from the effects of occupational exposure to ionizing radiation were also studied; the electroencephalograms showed a predominance of rapid potentials indicating excitatory processes (7 patients), low amplitudes, and slow rhythms indicating inhibition (11), or did not differ significantly from normal (11 patients). Electroencephalography carried out on 40 rabbits in which severe acute radiation sickness had been produced showed a reduction in amplitudes during the first few hours after irradiation, with slow waves of duration 0.3 to 0.25 sec. Histologically there was damage to the posterior root ganglia (chromatolysis of neurones) and sensory tracts (varicosity of the axons and vacuolation of the myelin sheaths). After 3 to 7 days there were motor disturbances (salivation, lacrimation, diarrhoea) and tachyrhythmia in the electroencephalogram. Death occurred after 7 to 13 days, and in the later stages the electroencephalographic changes showed some tendency to normalization. In 2 rabbits which recovered and were examined 9 months after irradiation, the cerebral cortex contained areas where the cells were shrunken and hyperchromatic, or showed hydropic dystrophia with chromatolysis and karyocytolysis. Similar appearances were found in 11 dogs which had survived radiation sickness as the result of intensive treatment. Studies with radioactive methionine carried out in 30 white rats subjected to 200 to 800 r showed that incorporation into the brain was first accelerated and then depressed. The results of the studies indicate that the central nervous system is very sensitive to ionizing radiation and shows evidence of damage almost immediately. (2) Digestive system. Complex radiological and pathological investigations were carried out on dogs and rats suffering from acute radiation sickness. During the first 24 hours after irradiation the stomach in dogs showed delayed emptying and loss of tone. The contrast medium did not disappear from the stomach and small intestine until the fourth day. A similar effect was noted in rabbits. Autopsy carried out after 72 hours revealed paralytic distension of the stomach, with vacuolation of the myelin sheaths and varicosity and fragmentation of the axons in the intramural nerve plexuses. There was vascular engorgement in the gastrointestinal tract and liver. In irradiated rats the uptake of labeled methionine was increased during the first 3 hours after irradiation; after 6 hours it declined but still remained higher than control values. (3) Heart and cardiac innervation. In patients receiving a dose of 5000 to 10,000 r from a cobalt source to the head for the treatment of malignant conditions of the scalp, there was some reduction in the amplitude of the auricular contractions and a prolongation of systole 4 to 5 days after irradiation. There was a reduction in voltage and deformation of the QRS complex and the T wave. The changes all reverted to normal 10 to 15 days after the end of irradiation. Among 40 persons suffering from the effects of occupational exposure to irradiation, 19 showed enlargement of the heart, reduction in the amplitude of the auricular beat was noted in 12 and blunting of the auricular waves in 9; sinus arrhythmia was present in 12, reduction of the T wave in 5 and absence in 6. In rabbits receiving irradiation to the skull in a dose of 6000 r over a period of 10 days, electrocardiography revealed arrhythmia, reduced-voltage and deformation of the waveform; these changes were at a maximum 10 to 12 days after the beginning of irradiation and then reverted to normal. In 30 rats irradiated with 200 to 800 r and injected with labeled methionine 1 hour later, increased incorporation into the heart muscle was noted after 1 hour; after 3 to 6 hours it declined, and after 24 hours the rate of incorporation was only 35% of the control value, in animals receiving the highest dose of radiation. Degenerative changes were found in the extra- and intramural cardiac nerves of rabbits given irradiation to the head (up to 50,000 r) or whole body (1000 r). Conclusion: The three systems investigated are involved in the picture of acute radiation sickness at a very early stage, the nervous system being particularly sensitive. (OTS)

30442 THE COURSE OF RADIATION SICKNESS IN CHANGED REACTIVITY OF THE CENTRAL NERVOUS SYSTEM. R. K. Arutyunyan (Radiobiological Section, Academy of Sciences, Armenian SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 47-57(1960).

An investigation was carried out on the effect of sulfazine (1% oily emulsion of sulfur) used as a cerebral stimulant in psychiatric patients, upon the electroencephalogram of rabbits suffering from acute radiation sickness. Electrodes were implanted beneath the visual cortex in 28 rabbits, 24 of which were then subjected to x-irradiation in a dose of 900 r. Eight irradiated rabbits were observed as controls. The electroencephalogram showed increased voltage in response to an interrupted light stimulator, followed after 1 week by reduced voltage and reduced ability to assimilate the rhythm of the stimulator. Eight other rabbits were given 2 intramuscular injections of 2 ml of sulphazine with an interval of 24 hours, followed 1 hour later by irradiation. The injections each provoked pyrexia, leucocytosis, and an increase in the reactivity of the brain. High frequencies (up to 22 cycles) of the stimulator were assimilated, but the ability to assimilate low frequencies was reduced. After 7 days voltages were reduced and assimilation of the imposed frequency was impaired. Six rabbits died after 5 to 9 days, and one after 28 days. In a third group of 8 rabbits, the two doses of sulphazine were given 1 hour and 7 days after irradiation respectively. After the first injection the potentials were increased and rapid rhythms appeared; after the second injection slow waves (3 to 5/sec) appeared, with a transient increase in voltages. The frequency of the light stimulator was assimilated only up to 10 to 12 cycles. These changes persisted for 2 to 3 days and then returned to normal. Four rabbits died after 23 to 28 days. The 4 rabbits not irradiated acted as controls of the effect of sulphazine. (OTS)

30443 HISTOCHEMICAL CHANGES IN THE LEUCOCYTES IN ACUTE RADIATION SICKNESS. E. A. Pareyshvili (Radiobiological Section, Academy of Sciences, Armenian SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 69-77(1960).

Early metabolic disturbances in the leucocytes after x-irradiation were carried out by histochemical methods on 100 white mice which were subjected to a lethal dose of 800 r. The ribonucleic acid content of the leucocytes as determined by the Brachet method began to fall 10 minutes after irradiation, and after 72 hours the cells had all lost their staining power, except for a very occasional cell which had presumably just been released from the bone marrow. In preparations stained by the Feulgen method to demonstrate deoxyribonnucleic acid, some loss of reticulation was noted in the nuclei of the leucoctyes 20 minutes after irradiation, and after 3 hours the staining had become diffuse and reduced in intensity. The decline in staining power continued until 72 hours, but deoxyribonucleic acid did not disappear completely and some was still present at death. The catalase activity of the neutrophils began to rise 5 minutes after irradiation and fell again after 3 hours. The fat metabolism of the cells was relatively radio-resistant; fat did not begin to accumulate in the cells until after 3 hours, and the changes were not marked until after 12 hours. (OTS)

30444 CHANGES IN THE GLYCOGEN OF LEUCOCYTES UNDER THE INFLUENCE OF IONIZING RADIATION (HISTOCHEMICAL INVESTIGATION). Yu. B. Kheyfets (Radiobiological Section, Academy of Sciences, Armenian SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 87-91(1960).

Thirty mice were subjected to a dose of 800 r of x-irradiation, and smears of blood made from them at intervals up to 72 hours thereafter were stained for glycogen by the method of Shabadash. A fall in the intensity of staining was noted in the leucocytes after 5 minutes, and after 20 minutes cells were present which contained no glycogen. These changes gradually became more marked until 12 hours after irradiation, when cells containing more than the normal amount of glycogen began to appear against a background of gradually intensifying leukopenia. The rise in glycogen constant was only temporary, and a fall set in after 24 hours which continued until the death of the animal. (OTS)

30445 THE EFFECT OF IONIZING RADIATION UPON THE CONCENTRATION OF VITAMIN B_{12}. M. O. Pogosyan (Radiobiological Section, Academy of Sciences, Armenian SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 103-5(1960).

The vitamin B_{12} content was determined by a microbiological method in the liver, kidney, spleen, and intestine of mice killed at intervals up to 7 days after exposure to x-irradiation in a dose of 760 r. Similar determinations were made on 12 unirradiated animals to establish baseline values; these showed that vitamin B_{12} was mainly present in the liver (53 mg/g) and kidneys (52 mg/g). Irradiation was followed by a rise in vitamin B_{12} content in all organs to a maximum of about 150% of the initial value. No explanation for this finding is offered. (OTS)

30446 THE ANTIBODY-FORMING FUNCTION OF THE BODY IN RELATION TO THE ROUTES OF INJECTION OF THE ANTIGEN AND THE TIMING OF THE ACTION OF IONIZING RADIATION. E. D. Stephanyan (Radiobiological Section, Academy of Sciences, Armenian SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 115-21(1960).

Rabbits were injected with an antigen intravenously, subcutaneously or intradermally, either 4 days before, or 4 days after, x-irradiation of the whole body in a dose of 350 r. The antigen consisted of a heated suspension of salmonella typhimurium containing 10 million organism per ml. Agglutinin titres were determined in samples of blood removed at intervals up to 21 days. Higher titres (256 to 1920) were obtained by intravenous immunization than by the subcutaneous (224 to 1408) or intradermal (192 to 896) routes. Irradiation carried out before immunization inhibited antibody formation, but to a lesser extent with intravenous administration (maximum titre 1280) than with subcutaneous (568) administration; with intradermal administration a rise in titre (2000) was noted on the 10th day, and values higher than normal persisted until death. When immunization preceded irradiation there was no inhibition of the immune response and some stimulation was noted, particularly with intravenous administration. A higher mortality occurred in the groups of rabbits in which irradiation preceded immunization. These two factors, both singly and in combination, led to a fall in the red and white cell counts, haemoglobin content, and prothrombin time. (OTS)

30447 THE EFFECT OF GENERAL X-IRRADIATION ON THE GENITAL SYSTEM OF WHITE MICE AND RABBITS (FEMALES). L. P. Markaryan and M. S. Ordoyan (Yerevan Inst. of Medicine, USSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 127-35 (1960).

Ten female mice in the second half of pregnancy and ten non-pregnant mice were subjected to x-irradiation in a dose of 418 r. Acute radiation sickness developed, and the manifestations and pathological findings are described at great length. In four pregnant mice which died 1 to 25 days after irradiation, there were marked changes in the cardiovascular system (acute fatty degeneration of the myocardium with areas of necrosis and hemorrhage) and massive hemorrhages in the internal organs. There were hemorrhages in the uterine horns and ovaries, with necrosis of the corporea lutea and ovarian follicles. All the layers of the uterus were infiltrated with blood. In mice which died after 25 days, the uterine cavity contained fetal remains in a state of petrification. Fifteen pregnant rabbits were subjected to x-irradiation in a dose of 676 r. Acute radiation sickness developed, and leucopenia was noted in the offspring. The results indicated that radiation sickness takes a more severe course in animals which are pregnant at the time of irradiation. (OTS)

30448 TREATMENT OF RADIATION SICKNESS COMPLICATED BY ACUTE BLOOD LOSS. M. A. Movsesyan (Radiobiological Section, Academy of Sciences, Armenain SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 177-80(1960).

An investigation was conducted of the effect of combined treatment with plasma substitutes, vitamin B_6, and chlortetracycline in animals subjected to x-irradiation and acute hemorrhage. Twenty four rabbits were irradiated with a dose of 800 r, and eight dogs with a dose of 700 r. The animals were then bled from the femoral artery so as to bring about a blood loss to the extent of 40 to 60% of the total blood volume. Immediately afterwards the plasma substitutes polyglucin and ArmIPK were injected intravenously in a volume equal to that of the blood removed. Chlortetracycline was given in the food in a dose of 25,000 units (rabbits) or 100,000 units (dogs) twice daily for 2 to 3 weeks. Vitamin B_6 was given in a dose of 0.2 ml of 1% solution until the red blood count returned to normal. The plasma substitutes were effective in reversing shock, and 17 rabbits and 6 dogs

survived the acute effects of the blood loss. Twelve rabbits and 1 dog survived the subsequently developing acute radiation sickness for a period of 3 months or longer. Six female rabbits which survived were mated, and 2 subsequently became pregnant and gave birth to normal litters. (OTS)

30449 THE EFFECT OF HYPOTHERMIA ON THE COURSE OF ACUTE RADIATION SICKNESS. G. A. Kazaryan and D. G. Saakyan (Radiobiological Section, Academy of Sciences, Armenian SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 181-6(1960).

Attempts were made to increase the radioresistance of animals by subjecting them to hypothermia. Rats were exposed to a dose of 800 r from an x-ray apparatus, and hypothermia was produced either before or after irradiation by treatment with lobeline hydrochloride and immersion in an ice bath. Appropriate controls were set up, and in all 110 rats were used. In rats cooled to 25 to 27°C before irradiation, the survival time was prolonged by 3 to 4 days, and by 1 day in animals cooled to 18 to 20°C. The acute radiation sickness took a milder course in the cooled animals than in the uncooled controls. The survival time was prolonged by 4 to 5 days in rats cooled after irradiation to 18 to 20°C, and by 1 day in rats cooled to 25 to 27°C. (OTS)

30450 AN INVESTIGATION OF OXYCAINE IN THE PROPHYLAXIS AND TREATMENT OF ACUTE RADIATION SICKNESS. M. A. Movsesyan and N. G. Mushegyan (Radiobiological Section, Academy of Sciences, Armenian SSR). Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 187-90(1960).

An investigation was carried out on the effect upon radiation sickness of oxycaine, a compound with a novocaine-like action synthesized in the Institute of Fine Organic Chemistry, AS Arm. SSR. The experiments were carried out on three groups of white rats; the first received oxycaine subcutaneously in a dose of 25 to 30 mg/kg 5 to 15 minutes before x-irradiation in a dose of 660 r; the second received the same dose both before and after irradiation; and the third group was irradiated only. The animals were observed for one month. A protective effect was observed in those treated with oxycaine; thus, 27 of 52 rats in the first group survived, 20 of 30 in the second, and 9 of 42 in the third group. The protective effect was much less when the dose of irradiation was increased to 770 r, and absent with a dose of 1200 r. No therapeutic effect was observed when oxycaine was given only after irradiation. (OTS)

30451 THE EFFECT OF IONIZING RADIATION UPON OXYGEN CONSUMPTION AND CERTAIN ASPECTS OF CARBOHYDRATE METABOLISM. S. P. Vlasenko, Yu. B. Kheyfets, and L. A. Chil-Akopyan. Vop. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr., 1: 191-6(1960).

An investigation was made of the effects of insulin and x-irradiation given singly or in combination, upon the oxygen consumption, blood-sugar level, and glycogen content of the leucocytes in rats. Exposure to 600 r was followed by a fall in all these quantities, which attained minimum values after 1.5 to 3 hr. A return to normal levels occurred after 24 hours. In animals given a single dose of insulin without irradiation, the blood sugar and oxygen consumption fell similarly, but a rise in glycogen content of the leucocytes occurred after 1.5 to 3 hours and persisted for 24 hours. The combined action of insulin and irradiation did not lead to any notable changes in these findings. (OTS)

30452 CHANGE IN THE CONTENTS OF ALBUMEN FRACTIONS IN BLOOD PLASMA CAUSED BY X-RAY IRRADIATION OF THE BODY. L. G. Prokopenko. Vopr. Med. Khim., 8: 242-7(1962).

The considerable drop in the albumen content of the blood plasma caused by irradiation is accompanied by an increase in the level of alpha- and beta-globulins. These reactions can be prevented by screening the liver with a lead sheet. Prior immunization of animals will bring about a sharp stimulation of globulin synthesis. (OTS)

30453 SENSITIVITY TO ACUTE BLOOD LOSS OF ANIMALS SUFFERING FROM RADIATION SICKNESS. M. A. Movsesyan. Vopr. Rentgenol. i Onkol., 4-5: 347-58(1960).

Dogs and rabbits subjected to a single severe blood loss fare poorly two hours after irradiation by 700–800 r, and also during the peak and convalescence periods of radiation sickness. Thus radiation sickness increases the sensitivity of animals, especially rabbits, to blood loss during all stages. (OTS)

30454 THE MOBILITY OF NERVOUS PROCESSES IN DOGS OF DIFFERING AGES, WHICH HAD PREVIOUSLY BEEN EXPOSED TO IONIZING RADIATION IN UTERO. M. G. Ayrapetyants (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Zh. Vysshei Nervnoi Deyatel'nosti im. I. P. Pavlova, 12: 1055-64(1962).

Pregnant bitches were exposed to total-body radiation by means of a single dose of 200 r. Nine of their puppies were used for the experiments and 9 healthy puppies served as the control group. Conditioned reflexes based on local and general motor responses were established at the age of 2 months and the mobility of the nervous processes was tested by reversing the signals, so that the formerly positive signal now became the negative signal and vice versa. At the age of 1 year the classical alimentary conditioned reflex based on salivation was established and the signals were again reversed. This test was repeated at the age of 1.5 years but now the task was facilitated by the introduction of a regular pattern with the formerly positive, and now negative stimulus always preceding the formerly negative (now positive) stimulus. It had earlier been shown by M. K. Petrova that such regular patterns enabled castrated dogs to cope with complex tasks, normally beyond their capacity. In both the experimental and the control dogs the reflex response to the buzzer underwent 3 consecutive phases. During the initial 'orientation reflex' consisting of a diffuse motor reaction, the response to the positive stimulus became less marked and the dogs were unable to recognize the differential signal, almost completing the reverse response to the signal given. This phase persisted in the irradiated dogs for 2 to 3 days but in the control group it happened only in a single experiment. In the second phase, the response corresponded to the previous, now reversed, meaning of the stimulus applied. This stage lasted 6 to 7 days in the irradiated and only 2 to 3 days in the control dogs. The intensity of the response in the experimental group showed sudden variation, from maximal 'explosions' to complete apathy or sleepiness, suggestive of a task outside the limits of the animals' capacity. The beginning of the third phase was marked by the first correct response to the new meaning of the reversed stimulus. This occurred after 8 to 9 days in the experimental group and after 3 to 4 days in the control group. In the latter group complete reversal was achieved, i.e., every stimulus was followed by the new, correct response. This could never be achieved in the irradiated dogs. The findings were the same for all age groups in question. Dogs irradiated in

utero thus seem to possess less labile nervous systems. This refers above all to the inhibitory process, which explains the pathological lability of the excitatory process. (OTS)

30455 TISSUE PHOSPHATASE ACTIVITY IN RATS FOLLOWING SUBACUTE AND CHRONIC PLUTONIUM INJURY. R. E. Libinzon and V. V. Konstantinova. p.80-5 of "Plutonii-239: Raspredelenie, Biologicheskoe Deystvie, Uskorenie Vyvedeniya." Moscow, Medgiz, 1962.

The effect of ionizing radiation on phosphatase activity was extensively studied. Experiments were carried out on 61 rats weighing 120 to 160 g. They were injected i.p. with 20 μC/kg b.w. (a dose causing a subacute injury) and 6.2, 3.7, and 1.9 μC/kg b.w. (chronic injury) of plutonium nitrate solution. The enzyme activity was determined with Bodansky's method. The acid phosphatase (pH = 4.8) and alkaline phosphatase (pH = 8.6) activity was determined in the corresponding buffer solutions. Sodium β-glycerophosphate served as a substrate and 0.5 to 5% tissue homogenates were the enzyme source. The enzyme activity was assessed by the increase in inorganic P following an incubation of 60 min at 37°C and determined by the Fiske-Subarrow method. The introduction of Pu to rats brought a slight increase in acid phosphatase activity and a two-fivefold increase in alkaline phosphatase activity in the liver 2, 6, and 9 months after the injection. The increase in alkaline phosphatase activity in hemopoietic organs was noticed only in cases of subacute injury. A twofold increase was observed in bone marrow 14 days and 2 months after injecting Pu, but in the spleen it was observed only after 2 months. A marked decrease in alkaline phosphatase activity was observed in the kidneys and intestinal mucosa in subacute and chronic injuries during the entire period of the experiment. (OTS)

30456 THE ROLE OF HORMONES OF THE MEDULLA OF THE SUPRARENAL GLAND IN DISORDERS OF THE CARBOHYDRATE METABOLISM DUE TO THE INFLUENCE OF IONIZING RADIATION. B. M. Graevskaya. p.157-61 of "Deystvie Ioniziruyushchikh Izluchenii na Organizm." Moscow, Publishing House of the Academy of Sciences, 1962.

An endeavor is made to clarify the dependence of the carbohydrate metabolism (glycogen and blood sugar) of the irradiated organism on the content of total adrenalins. Male white mice were whole-body irradiated with 600 r or 2000 r. In an interval t after irradiation blood sugar, glycogen, and catecholamine content of the suprarenal gland were determined. In the case of 2000 r, the animals died before the fourth day after irradiation. In both experimental series an increase of the total adrenalin content of the suprarenal glands is accompanied by a reduction of the glycogen level, and vice versa. No simple relation with the fluctuations of blood sugar level could be found. It may be assumed that the glycogen content of the liver after irradiation depends on the adrenalin level changed by the radiation effect. (OTS)

30457 EFFECT OF RADIATION BLOCKERS ON SURVIVAL AND CHANGES IN THE INTERNAL ORGANS OF X-RAY IRRADIATED MICE OF DIFFERENT RADIOSENSITIVITY (DIETHYL STILBESTROL EFFECT). N. I. Nuzhdin and I. A. Nechaev. p.173-97 of "Deystvie Ioniziruyushchikh Izluchenii na Organizm." Moscow, Publishing House of the Academy of Sciences, 1962.

Three inbred strains of mice, CC_{57}-brown (I), C_3H(II), and BALB/c(III), were subjected to a single whole-body irradiation of 600 r in order to study the effect of one prophylactic sc injection of 0.2 mg diethyl stilbestrol propionate (D) administered 10 days before irradiation. The $LD_{50/30}$ for these mice were 538, 490, and 442 r, respectively. Administration of D reduced the total mortality by 50% in I and II and by 66.7% in III, the first peak (up to 5 days) being significantly reduced and the second peak (10 to 12 days) disappearing almost completely. The weights of thymus, liver, spleen, suprarenal glands, and testes were determined 2, 4, 7, 14, 21, 30, and 60 days after irradiation. Groups II and III differed originally only in the weight of the testes, but group I had distinctly higher liver and spleen weights than the two others. In non-irradiated mice, D administration did not affect the total body weight. The radiation-induced weight variations of the thymus were similar in the 3 groups and not affected by D. The highest weight of liver with the least fluctuations was found in the most radioresistant strain I. The effect of D on this organ became evident 2 weeks after the irradiation. The weight curves of the spleen whose radiosensitivity is reflected in the second peak of the mortality curve (failure of the hematopoietic system) showed the highest absolute values and an earlier period of overcompensation in group I. D accelerated regeneration, inhibited overcompensation, and equalized the otherwise differing spleen reactions of the 3 strains. The weight increases of the suprarenal glands produced by separate and combined irradiation and D administration were similar in the 3 groups. The difference in natural radiosensitivity was not reflected in the weight curves of the testes whose regeneration was not improved by D. The divergent radioresistance of the 3 strains is attributed to the different radioresistance of their spleen and liver, which is evident from the weight curves as well as the diethyl stilbestrol effect. (OTS)

30458 PROTECTIVE ACTION OF DIETHYL STILBOESTROL IN GOLDEN HAMSTERS IRRADIATED WITH X-RAYS. I. A. Nechaev. p.198-203 of "Deystvie Ioniziruyushchikh Izluchenii na Organizm." Moscow, Publishing House of the Academy of Sciences, 1962.

To obtain further data on the protective effect of diethyl stilboestrol (D), male golden hamsters weighing 120 to 125 g were subjected to a single, whole-body x-ray treatment of 400 r or 600 r (50 r/min). 9 to 10 days before irradiation, the test animals but not the controls were injected 1.2 mg D subcutaneously. Test and control animals were weighed every 4 days during the first month after irradiation, then on the 45th and 60th day, and afterwards every 30 days. The protective effect of D was found to be less than that of mercaptoethylamine (M), but the staphyloma-like eye damages which occurred in the surviving animals after M application could not be observed after D. The death rate for golden hamsters differed from that for rats and mice. Three maxima were observed: the first (4th to 7th day after irradiation) corresponds to a lethal effect of the gastrointestinal syndrome which previous experiments had shown to occur only after radiation doses from 1000 r upwards. The second (8th to 12th day) is due to a damage of the hematopoietic system. This maximum may be reduced (at 600 r) or eliminated (at 400 r) by applying D, contrary to the third maximum (17th to 20th day), which is hardly changed. The time of surviving from the 60th day after irradiation onwards was not affected by D. On comparing the weights of the golden hamsters on the 28th day after irradiation, the natural increase in weight of the surviving animals after irradiation with 400 r and 600 r was found to be somewhat less than without irradiation. A prophylactic treatment with D results in an additional delay of growth, but this decreases in the course of

time and is no longer observed on the 270th day after irradiation. After that time, the initial weight of non-irradiated animals was increased to 160%, that of animals irradiated with 400 r to about 135%, and that of animals irradiated with 600 r to ca. 120%. (OTS)

30459 THE INFLUENCE OF THE TIME DISTRIBUTION OF THE DOSE ON THE BIOLOGICAL EFFECT OF X-RAYS. W. Angerstein. Thesis, Berlin, Universität, 1962. 113p. $2.00.

The influence of the time distribution of the dose on radiation effects after whole-body irradiation of 4000 mice with 100 kvp x rays is studied. $LD_{50/30}$ was taken as index for radiation damage. Values for $LD_{50/30}$ are given for continuous irradiation with 10 different dose rates (1.36 to 139.5 r/min). For dose rates which are larger than 50 r/min, LD_{50} remains constant. For 1.36 r/min, a value of 987 r was observed. Mortalities for fractionated irradiations with constant pulse duration and doses using invervals from 1 to 16 min are given. No dependence of LD_{50} on the sex of mice was observed. Recovery time of damage was determined using the theory of Lea. A dynamic model for the explanation of the results using two dependent recovery processes is proposed. (Gmelin Inst.)

CHEMISTRY

General and Miscellaneous

30460 SOME NOTES TO THE INVERSION CURVE. I. GENERAL CONSIDERATIONS; THE INVERSION TEMPERATURE. W. Koeppe (Kernforschungsanlage, Julich, Ger.). Kaeltetechnik, 14: 399-403(1962). (Jul-108-RX). (In German)

Recent results of investigations on the differential and, partially, the integral inversion curves are discussed. The general form of the differential inversion curve in the p vs. T-Diagram is given, supplemented by some rules for correlating data of measurements on Thomson-Foule effects, specific heats at constant pressure and equation of state. For a series of gases values of the inversion temperature T_i are given with a representation of the reduced inversion temperature ϑ_i as a function of the critical parameter α_k. (auth)

30461 EFFECTS OF ACID MEDIA ON NIOBIUM, TANTALUM, AND TITANIUM CONTENT IN ANALYTICAL CHEMICAL SOLUTIONS. E. S. Bruile and N. S. Dombrovskaya (Scientific Research Inst. of Construction and Chemical Engineering, USSR). Zh. Prikl. Khim., 36: 910-12(Apr. 1963). (In Russian)

Tabulated data on sulfuric acid effects on Ti, Nb, and Ta showed that Ta is a subject of highest hydrolysis, at H_2SO_4 46 wt % the solution retained only 0.036 wt % Ta. The least hydrolysis was observed with Ti where at H_2SO_4 30 wt % the solution retained 0.534 wt % Ti. An intermediate position was occupied by Nb where at H_2SO_4 46.0 wt % Nb content was 0.414 wt %. (R.V.J.)

30462 THE DYNAMICS OF ION EXCHANGER CATALYSIS. P. E. Gruber, Jr. Thesis, Munich, Technische Hochschule, 1962. 93p. $2.00.

The influence of diffusion of reagents into the pores of ion exchangers on their properties as catalysts is investigated. The catalytic activity of the ion exchangers decreases during the reaction. Application of ion exchangers for continuous operation is discussed. (Gmelin Inst.)

30463 THE INVESTIGATION OF SURFACES BY NUCLEAR METHODS. Robert F. Sippel and E. D. Glover (Socony Mobil Oil Co., Inc., Dallas). 22p. (CONF-37-3)

From American Chemical Society Southwest Regional Meeting, Dallas, Dec. 1962.

A discussion is presented of the possible analysis of surfaces by charged-particle bombardment or activation. The processes involved in the bombardment are described, and schematic proton spectra are given which might be obtained from bombardment of various types of targets. The surface analysis method is illustrated by two applications, (d,p) studies of the surface oxidation of iron and (p,γ) studies of the rate of growth of pseudomorphic fluorite films on calcite by reaction with HF. Growth-rate curves are given for both applications. (D.L.C.)

Analytical Procedures

Refer also to abstracts 29889, 29890, 29893, 29894, 29950, 29954, 29955, 29958, 30036, 30038, 30052, 30094, 30113, 30114, 30115, 30116, 30117, 30118, 30119, 30121, 30185, 30187, 30214, and 30219.

30464 (AERE-R-4292) THE ESTIMATION BY PAPER CHROMATOGRAPHY OF NITRO- AND NITRATO-COMPLEXES OF NITROSYLRUTHENIUM IN PROCESS SOLUTIONS. D. Scargill and C. E. Lyon (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1963. 22p.

The parameters affecting the separation of nitrosylruthenium nitrato- and nitro-complexes by paper chromatography were studied, and a comparatively labile species is postulated to account for some anomalous behavior. The former paper chromatographic method for the estimation of the proportions of nitro- and nitrato-complexes was found to be sensitive to the precise conditions used. For process solutions containing uranyl nitrate, a modified procedure is given which uses the results from elution with dibutyl cellosolve. This method indicates a higher proportion of nitro-complexes in process solutions than was found previously. (auth)

30465 (BNL-800) DETERMINATION OF URANIUM AT MICROGRAM LEVELS. BY DERIVATIVE POLAROGRAPHY. Clemens Auerbach and George Kissel (Brookhaven National Lab., Upton, N. Y.). May 1963. Contract [AT(30-2)-Gen-16]. 7p. (BNL-T-307)

The incremental method of derivative polarography was applied to the low-level analysis of uranium in acetate-buffered EDTA electrolyte. Optimum conditions are shown for the rapid determination of 2×10^{-6}M uranium in the presence of 0.01M bismuth and of 5×10^{-6}M uranium in the presence of 0.01M molybdenum, with a precision $\leq 2\%$ and without prior separation. Uranium in amounts ≤ 10 μg may be detected in a 10^4-fold excess of bismuth. The method was successfully used for the analysis of a bismuth alloy containing 0.1% uranium. (auth)

30466 (CONF-14-13) DETERMINATION OF NITROGEN, OXYGEN, HYDROGEN IN METALS BY INERT GAS FUSION. A MANOMETRIC METHOD. Ben D. Holt and Harvey T. Goodspeed (Argonne National Lab., Ill.). [1962]. Contract [W-31-109-eng-38]. 20p.

Capillary manometers were used for the simultaneous determination of microgram quantities of nitrogen, oxygen, and hydrogen by the inert-gas fusion technique. The gases evolved from fusion of the sample are carried by helium, first through hot copper oxide for oxidation of H_2 to H_2O and CO to CO_2, then through capillary-manometer cold traps for the isolation and subsequent measurement of H_2O (at 110°C) and CO_2, and finally through activated charcoal at −196°C for the removal of N_2. The N_2 is transferred by Toepler pump to a capillary manometer for measurement. The time required for a complete analysis is about 25 minutes; less, if all three elements are not required. Sensitivity and precision are about the same as for the vacuum fusion method. (auth)

30467 (CONF-17-4) DETERMINATION OF BERYLLIUM BY THE PHOTONEUTRON METHOD. Gerald Goldstein (Oak Ridge National Lab., Tenn.). [1962]. Contract [W-7405-eng-26]. 23p.

From Oak Ridge Radioisotopes Conference, Applications to Physical Science and Engineering, Gatlinburg, Tenn., Apr. 1963.

Apparatus was designed and constructed for the determination of beryllium by the photoneutron method, which

can be employed in any analytical laboratory without hazard or difficulty. Because large $B^{10}F_3$ neutron counter tubes are used, the neutron detection efficiency of the instrument is sufficiently great so that a γ source activity of only ~ 300 millicuries of Sb^{124} is necessary for most samples. With this source activity sample solutions containing as little as 60 μg of Be per ml, or 1.5 mg total beryllium, can be analyzed with a relative standard deviation of 1%. Interference caused by elements which absorb neutrons can be eliminated by the cadmium shield technique. Deuterium is an interference if present in a 25-fold excess over beryllium. Results are shown for the determination of beryllium in several types of materials. (auth)

30468 (CONF-48-1) THE POROUS CUP REVISITED—RECENT IMPROVEMENTS IN MATERIALS AND TECHNIQUES. Cyrus Feldman (Oak Ridge National Lab., Tenn.). [1962]. Contract [W-7405-eng-26]. 20p.

From Conference on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Mar. 1963.

Causes of variance from the use of porous cups in spectroscopy are discussed. Electrical excitation conditions were examined. Tests were made of the electrical and mechanical properties of porous-cup electrodes made of various batches and brands of graphite and carbon. The reproducibility of an ill-matched arc-spark pair from one electrode to the next and the reproducibility of various arc-arc and arc-spark pairs belonging to common elements were investigated. Dimensions, solution compositions, and power levels were also studied. (M.C.G.)

30469 (CONF-48-3) DETERMINATION OF TOTAL URANIUM AND URANIUM-235 ON SPUN FIBERGLASS FILTERS. A. J. Moses, T. B. Crockett, and J. T. Green (Thompson Ramo Wooldridge Inc., Cleveland). [nd]. Contract AT(11-1)-Gen-8. 5p.

From Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, March 1963.

A method of determining uranium content and enrichment on filters in the ventilation system in fuel processing plants is described. Fiberglass filter specimens 2 × 2 in. are cut from the filter and weighed. Dust is removed by boiling in HNO_3, with additions of HCl. The solution is filtered, H_2SO_4 is added, and then it is evaporated to dryness. The residue is dissolved in H_2SO_4 and an aliquot electrolyzed. The electrolyzed solution is titrated with standard sulfato cerate using ferroin indicator. U^{235} is determined by integration of the photopeak from its 0.184-Mev gamma ray. (M.C.G.)

30470 (GAT-T-1118) THE COLORIMETRIC DETERMINATION OF THORIUM IN URANIUM COMPOUNDS. C. R. Walker and C. F. Trivisonno (Goodyear Atomic Corp., Piketon, Ohio). July 19, 1963. Contract AT(33-2)-1. 19p.

A method for the determination of thorium in uranium compounds was developed. The uranium is separated by adsorption on an anion exchange resin from 7M hydrochloric acid. Thorium is determined in the effluent by developing and measuring the color of the thorium complex with Arsenazo. One microgram of thorium per gram of uranium can be detected; in determining 100 μg, the limit of error is 3.7%. (auth)

30471 (GAT-T-1120) THE COLORIMETRIC MICRODETERMINATION OF TUNGSTEN IN URANIUM COMPOUNDS. C. R. Walker and C. F. Trivisonno (Goodyear Atomic Corp., Piketon, Ohio). July 24, 1963. Contract AT(33-2)-1. 10p.

A method for the rapid microdetermination of tungsten in uranium compounds was developed. Tungsten(VI) is reduced to tungsten(V) using amalgamated bismuth and stannous chloride in concentrated hydrochloric acid. The yellow tungsten(V)–thiocyanate complex is then formed and extracted with butyl acetate. The tungsten content is determined by comparing the optical density of the extract at a wave length of 405 mμ to a standard curve. From 1 to 250 micrograms of tungsten can be determined in the presence of two grams of uranium. Only molybdenum interferes seriously and its interference can be eliminated by pyrohydrolysis of the sample or by a simple colorimetric correction. Twenty-five micrograms of tungsten can be determined with a precision of ±5%. (auth)

30472 (PG-Report-481) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF BORON IN ALUMINA POWDER. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 7p.

The alumina is dissolved under reflux in sulfuric acid and phosphoric acid. Boron is separated by distillation as methyl borate and determined absorptiometrically as rosocyanin. The range of the method as written is 0.2 to 3 ppm boron, but this may be extended by using a smaller sample. The standard deviation at the 0.5 ppm level is ±0.04 ppm. (auth)

30473 (PG-Report-483) ANALYTICAL METHOD FOR THE DETERMINATION OF IRON AND NICKEL CARBONYLS IN CARBON MONOXIDE AND CARBON DIOXIDE. (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1963. 10p.

The gas is passed through a heated silica tube containing a plug of silica wool. The carbonyls decompose leaving deposits of iron and nickel which are determined by standard absorptiometric procedure. The method is intended for the determination of carbonyls in reactor coolant gas mixtures of carbon monoxide and carbon dioxide and in the original constituents before mixing. (auth)

30474 (AEC-tr-5880) ELECTROANALYSIS. COMMUNICATION 5. H. Ogino, K. Ebata, R. Tamamushi, K. Nakano, and M. Munemori. Translated for Los Alamos Scientific Lab., N. Mex. from Bunseki Kagaku, 11: 21R-36R(1962). 30p.

A review is given of 555 references on electrochemical analysis theory, techniques, apparatus, fundamental problems, and applications. The methods discussed are: potentiometric titration, amperometric titration, conductometric methods, high-frequency methods, electrolysis analysis, and coulometric analysis. (N.W.R.)

30475 (AEC-tr-5912) ANALYSIS OF CHLORINE, CARBON MONOXIDE AND CARBON DIOXIDE BY VAPOR PHASE CHROMATOGRAPHY. Hiroshi Shimizu and Tomoo Kirihara. Translated for Ames Lab., Ames, Iowa from Nagoya Kogyo Gijutsu Shikensho Hokoku, 9: 453-7(1960). 9p.

A method was investigated for determining CO, CO_2, and Cl_2 simultaneously and promptly by gas-liquid chromatography. The best separation efficiency was obtained with a diethylphthalate column using 50% diethylphthalate to the solid support, because the gases are adsorbed on solid supports. Stainless steel tubing, 2m long and 5 mm internal diameter, packed with the diethylphthalate on fire brick, was used as a partition column. The temperature was 40°C and the helium flow rate was 30 ml/min. The amplitude of the peak of the chromatogram was measured. Tungsten filament was used as the thermal conductivity detector. (M.C.G.)

30476 NOTES ON THE METHODS OF TRACE ELEMENT DETERMINATION BY SPECTROANALYSIS. J. Minczewski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Acta Chim. Acad. Sci. Hung., 34: 123-33(1962). (In German)

On the basis of results obtained in the determination of U traces in minerals, of trace contaminants in nuclear-purity U, and of trace contaminants in high-purity W and Cr, the accuracy and reliability of the various spectrographic, flame photometric, and spectrophotometric methods are discussed. Spectrography combined with chemical enriching appeared to be the most suitable method for routine analyses.

30477 ABSOLUTE DETERMINATION OF THE ACTIVITY OF $C^{14}O_2$ IN A GAS COUNTER WITH SUBDIVIDED COUNTER WIRE. M. Leistner and M. Diettrich (Institut für Angewandte Radioaktivität, Leipzig). Atomkernenergie, 8: 224-5(June 1963). (In German)

A description is given of an absolute activity estimation of $C^{14}O_2$ in a gas counter with subdivided counter wire. The gas counter is operated within the Geiger-Müller range having a dead time stage with a blocking time greater than the recovery time of the gas counter. Thereby, definite pulse heights are obtained from each segment of the counter wire and the pulse rates belonging to the partial volume can be estimated with the aid of a discriminator or analyzer. Therefrom, the C^{14} activity present in the counter volume can be calculated. (auth)

30478 DETERMINATION OF RADIOTHORIUM IN ORGANIC MATERIALS, ESPECIALLY IN BONES. K. J. Godt, D. Klokow, E. Klug, K. Sommermeyer, H. Weisz, and D. Weithoener (Universität, Freiburg i. B.). Atomkernenergie, 8: 232-5(June 1963). (In German)

A method of Th^{228} measurement in organic substances was developed. The method combines chemical and physical procedures. The Th^{228} activity of grass and leaves was measured between 0.2 and 2.1 $\mu\mu c/g$ ash, of cow bones between 0.4 and 2.4 $\mu\mu c/100$ g ash, and of human bones between 0.06 and 0.43 $\mu\mu c/100$ g ash. (auth)

30479 MEASUREMENT OF POWER AND BURN-UP IN IRRADIATED NUCLEAR REACTOR FUEL BY A NON-DESTRUCTIVE METHOD. T. D. Owen (United Kingdom Atomic Energy Authority, Windscale, Cumb, Eng.). Brit. J. Appl. Phys., 14: 456-8(July 1963).

A simple non-destructive test for measuring power and burnup in irradiated nuclear reactor fuel is described. The method involves scanning the fuel elements via a slit in shielding for gamma activity of two specific fission products. A short half-life fission product gives a measure of power production in the fuel for the period immediately preceding the discharge, while a long half-life product gives a measure of power integrated over the whole irradiation period. Calibration of the system by standard sources or radiochemical analysis enables actual values of power and burnup, as well as distribution, to be obtained. (auth)

30480 THE INDEX OF REFRACTION OF BERYL AS A FUNCTION OF ITS COMPOSITION AND CONDITIONS OF FORMATION. I. G. Pavlova (All-Union Research Inst. of Geology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 150: 385-8(May 11, 1963). (In Russian)

Over 100 measurements of the index of refraction were made on beryls from various formations, and the results were correlated with the alkali metal content ($Na_2O + K_2O$) determined by flame photometry or chemical analysis. Beryls formed in ores of high basicity at an average pH of 9.5 to 10 show a high content of alkali metal (0.59 to 2%), and also of other elements such as Fe, Cr, Mn, and Ni which tend to increase the index of refraction. The average value of the index of refraction N_0 varies from 1.569 to 1.586. In general, the index of refraction increases with increasing basicity of the ore in which the beryl deposit is found. Thus, the average index of refraction (N_0 = 1.582 to 1.584) from albites is higher than that (N_0 = 1.569 to 1.575) from gneisens because of the higher basicity. Thus, the highest indices of refraction are characteristic of beryls formed during an alkaline stage of replacement in a basic ore, and the lowest indices of refraction occur during an acidic stage of replacement in an acid ore. (TTT)

30481 THE USE OF BROMINE PENTAFLUORIDE IN THE EXTRACTION OF OXYGEN FROM OXIDES AND SILICATES FOR ISOTOPIC ANALYSIS. Robert N. Clayton and Toshiko K. Mayeda (Univ. of Chicago). Geochim. Cosmochim. Acta, 27: 43-52(Jan. 1963). (In English)

A technique was developed in which bromine pentafluoride is used as a reagent for quantitative liberation of oxygen from oxides and silicates. For all of the rocks and minerals analyzed, the oxygen yields are 100 ± 2 per cent of the theoretical amount. The advantage over techniques involving reduction with carbon lies in the consistently better oxygen yields, with consequent decrease in systematic errors in isotopic composition. Bromine pentafluoride has advantages over fluorine in being easier and safer to handle in the laboratory, in being readily purified, and in reacting with some minerals which do not react completely with fluorine. The results of isotopic analyses are compared with measurements made in other laboratories by other procedures. (auth)

30482 A LIGHT SOURCE FOR THE ISOTOPIC ANALYSIS OF URANIUM BY EMISSION SPECTROMETRY. M. Ceccaldi, P. Goujon, J. P. Leicknam, and G. Nief (CEN, Saclay, France). J. Phys., 24: Suppl. to No. 3, 65A-8A (Mar. 1963). (In French)

A process is described for producing and exciting electrodeless uranium tetrachloride or tetraiodide lamps, emitting the optical spectrum of uranium with an intensity, a purity, and a stability sufficient to allow the isotopic analysis to be carried out with an interference spectrometer. The process of fabrication is simple and rapid, and can be used for routine analyses. (auth)

30483 X-RAY MICROANALYSIS OF THE LIGHT ELEMENTS. R. M. Dolby (Cambridge Univ., Eng.). J. Sci. Instr., 40: 345-51(July 1963).

The main aspects of the problem of long wavelength x-ray spectrometry and detection are considered, and it is concluded that a proportional counter and pulse analysis system is the best approach for practical light element ($Z < 12$) scanning microanalysis. A suitable pulse analysis method, in which several pulse analyzer outputs are treated as a set of linear equations which can be solved in a network, was developed. The method and its incorporation into a scanning microanalyzer are described. Several x-ray images showing the elements Be, C, and O demonstrate the performance of the instrument. (auth)

30484 ANALYSIS OF ADJACENT ELEMENTS IN X-RAY SPECTROSCOPY WITH RADIOISOTOPES. Takashi Tanemura (Rigaku Denki Co., Tokyo). Japan J. Appl. Phys., 2: 347-53(June 1963). (In English)

X-ray fluorescence analysis was carried out with H^3/Zr and Pm^{147}/Al as primary x-ray sources. For spectroanalysis, pulse analysis with proportional counter and

electronic pulse height analyzer or x-ray filter is applied. In the He flow small specimen chamber, light elements as Na, Mg, Al, and Si were detected. Al_2O_3 and SiO_2 mixtures were analyzed with Al filter. Pulse analysis technique was applied to three element system, Cr_2O_3-Fe_2O_3-NiO mixtures, and effects of overlapped spectra were examined. Accuracies of the analysis are 0.3% for 10–20% Cr_2O_3, 1% for 70–100% Fe_2O_3 and 2% for 5–10% NiO in a counting time of one minute. (auth)

30485 PHOTOMETRIC DETERMINATION OF A SMALL AMOUNT OF THORIUM IN THE PRESENCE OF CERIUM BY AN OXINATE EXTRACTION METHOD. Tsugio Takeuchi, Daido Ishii, and Yashia Shija (Nagaya Univ., Japan). Kogyo Kagaku Zasshi, 65: 1956-9(Dec. 1962).

A small amount of Th in the presence of large amount of Ce could be extracted quantitatively at pH 5 by oxine in benzene solution (1 g oxine/100 ml benzene). The extracted Th and free oxine in the benzene phase were then re-extracted by 0.6N HCl. A 0.1% aqueous solution of thorin was added to the acid extract and its absorbance at 545 mμ was measured using 1-cm cell. A slightly nonlinear but reproducible calibration curve was obtained. Samples containing more than 0.1% Th can be determined by this method. (H.H.D.)

30486 DETERMINATION OF THORIUM IN ROCKS. N. G. Syromyatnikov, M. V. Eirish, F. M. Mykashev, L. A. Kapinskaya, and V. S. Demen'tev. Radiokhimiya, 5: 164-70(1963). (In Russian)

A method was developed for isotopic determination of thorium (Th^{238}, Th^{230}, and Th^{234}) based on α- and β-measurements (RdTh, Io, and UX_1) and colorimetric determination of electrolytically separated thorium deposited on steel discs. Thorium separation from other radioactive materials and was achieved using selective Th sorption by cation KU-2 followed by elution with complexone III. (R.V.J.)

30487 DETERMINATION OF ULTRASMALL QUANTITIES OF URANIUM, RADIUM, AND THORIUM ISOTOPES IN A BATCH OF SILICATES. Yu. V. Kuznetsov, V. K. Legin, and Z. N. Simonyak. Radiokhimiya, 5: 189-97 (1963). (In Russian)

Separation of U, Ra, and Th from a batch of silicate material was achieved by roasting the material with NH_4F and separating thorium by precipitation with CaC_2O_4 followed by melting with $K_2S_2O_7$ and sorption into a cation. The method eliminates the effects of fluorine ions and permits a simultaneous separation of U and Ra. (R.V.J.)

30488 EXTRACTION OF PLUTONIUM(IV) FROM NITRIC ACID SOLUTIONS BY OXYGEN CONTAINING AGENTS. V. A. Khalkin, P. N. Palei, and A. A. Nemodruk. Radiokhimiya, 5: 215-22(1963). (In Russian)

Studies of plutonium(IV) extraction from nitric acid solutions by oxygen-containing agents (diethyl and di-n-butyl ether, diethylketone, methyl-n-butyl ketone, methyl-isobutyl ketone, n-butylformate, ethyl acetate, n-butyl acetate and benzaldehyde) without salting-out agents showed that diethyl ether is a most effective extraction with distribution coefficient 11.5 at equilibrium nitric acid concentration 5.0 and 3.4M in aqueous and organic phases respectively. Spectrophotometric and direct organic phase analysis indicated that Pu(IV) is extracted as oxonium compound $H_2[Pu(NO_3)_6]$. (R.V.J.)

30489 INFRARED SPECTRA OF THORIUM, ZIRCONIUM, AND URANYL COMPLEXES WITH 8-OXINE AND TRIBUTYLPHOSPHATE. V. I. Gaivoronskii, O. A. Osipov, and R. R. Shagidullin. Radiokhimiya, 5: 244-8(1963). (In Russian)

Reactions of Zr, Th, and UO_2 with 8-oxines and $ZrCl_4$ and $ThCl_4$ with TBP were studied. Infrared absorption spectra of Th, Zr, and UO_2 8-oxinate exhibited the presence of a conjugation effect. The infrared spectra indicated that the extra 8-oxine molecule is added by the coordinate bond between the atom of the metal and nitrogen of the mixture. Infrared spectra for TBP mixtures with $ThCl_4$ and $ZrCl_4$ were measured and the mechanism of component reactions was analyzed. (R.V.J.)

30490 COMPLEX FORMATION OF THORIUM WITH MANDELIC AND α-HYDROXYISOBUTYRIC ACIDS. A. V. Lapitskii, I. Geletseanu, and Ya. Mink. Radiokhimiya, 5: 249-58(1963). (In Russian)

Optimum conditions producing various thorium complexes with mandelic and α-hydroxyisobutyric acids were studied by ion exchange method. Thorium complexes $[ThA]^{3+}$, $[ThA_2]^{2+}$, $[ThA_3]^{1+}$, and $[ThA_{3.5}]^{0.5+}$ form with acid concentrations from 0.01 to 0.1 M, $\mu = 0.2$ and pH = 2.2. The stability constants of formed complexes were determined and correlated. (R.V.J.)

30491 THERMODYNAMICS OF RARE EARTH AND ACTINIDE ATOMS AND IONS. G. A. Krestov. Radiokhimiya, 5: 258-70(1963). (In Russian)

Statistical thermodynamics were used for calculating the entropy of various gaseous atoms and ions of rare earths and actinides. Modified Pauling and Latimer equations, considering ion entropy electron components in a solution, were used for estimating the ion entropy in a solution. Characteristics of triple and quadruple charged rare earth and actinide ions in gaseous state and in solution were analyzed, and their ionization and oxidation-reduction potentials were determined. (R.V.J.)

30492 MASS-SPECTROMETRIC DETERMINATION OF MICROQUANTITIES OF CESIUM. I. V. Burovina, V. P. Nesterov, and D. G. Fleishman. Radiokhimiya, 5: 272-6 (1963). (In Russian)

Mass-spectrometric method was used for determining Cs^{133} in biological objects. The half-life of Cs^{137} was determined as 30.1 ± 0.7 years. Data are given on Cs^{133} content in a human brain and muscle. (R.V.J.)

30493 DETERMINATION OF SMALL QUANTITIES OF THORIUM WITH THE AID OF NEUTRON IRRADIATION. V. V. Cherdyntsev, L. I. Shmonin, and V. F. Ostapenko. Sb. Nauchn. Rabot Kafedry Optiki i Kafedry Experim. Fiz. Kazakhsk. Univ., No. 2, 13-16(1960).

To determine small quantities of Th (down to 10^{-4} g) in extracts of some minerals, a method based on the recording of fragments from the fission of Th nuclei during irradiation by neutrons from a Ra–Be source was used. Thorium is removed from solution by co-precipitation with Ce oxalate and the precipitate is placed in an ionization chamber. It is then irradiated with a beam of fast neutrons and a number of fission events is recorded. Measurements are made of the number of fission events produced by fast and partly slowed-down neutrons in the presence of U. (Referativnyy zhurnal, Khimiya, No. 11, 1962)

30494 SEPARATION OF BARIUM FROM STRONTIUM USING COMPLEXONE III. A SULPHATE METHOD FOR SEPARATING ALKALINE EARTH ELEMENTS. L. I. Afanaseva (Lab. for Pre-Cambrian Geology, Leningrad). Zh. Analit. Khim., 18: 712-16(June 1963). (In Russian)

A method was developed for separating Ba and Sr as sulfates in solutions containing complexone III at pH 6.4

to 6.8. The method was tested on synthetic mixtures of salts for 5 to 50 mg of Ba and Sr and their ratios from 1:10 to 10:1. A sulfate method was suggested for separating Ba, Sr, and Ca in complexone-containing solutions. A method is also described for the separation and determination of small amounts of Ba and Sr in rocks. (auth)

30495 SPECTROPHOTOMETRIC DETERMINATION OF SAMARIUM AND EUROPIUM. V. I. Ganopolskii, T. A. Ganopolskaya, and V. F. Barkovskii (Gorkii Ural State Univ., Sverdlovsk, USSR). Zh. Analit. Khim., 18: 729-33 (June 1963). (In Russian)

A spectrophotometric method is suggested for the determination of Sm by its absorption band at 1090 mμ and Eu by its absorption band at 394 mμ with the use of the infrared band of Sm absorption. The method may be successfully used for determining Eu and Sa in their concentrates of any composition, as well as in technical Sm an Eu oxides. The method may be also used for the express-analysis in the control of technological procedures of Sm and Eu separation. (auth)

30496 NEW PHOTOMETRIC METHODS FOR THE DETERMINATION OF NIOBIUM AND TANTALUM IN METALS AND ALLOYS. COMMUNICATION 2. PHOTOMETRIC DETERMINATION OF NIOBIUM WITH XYLENOL ORANGE. S. V. Elinson and L. I. Pobedina. Zh. Analit. Khim., 18: 734-8(June 1963). (In Russian)

A study was made of the Nb complex with xylenol orange in the presence of ammonium oxalate. The optical density of the colored complex in this medium is higher than in peroxide and fluoride media. The maximum absorbance of the complexes is at 570 mμ. (The reagent absorbs at 445 mμ.) It was established that Nb reacts with xylenol orange in the presence of $C_2O_4^{2-}$ in the ratio of 3:2. The color is stable up to the ratio $Nb:C_2O_4^{2-} = 1:20$. With further increase of oxalate concentration the color becomes less intense. The rate of complexing increases on heating. The molar extinction coefficient in the presence of tenfold excess of $C_2O_4^{2-}$ is ~14000. A method was developed for the determination of Nb in alloys with U, Mo, and W. The sensitivity of the method is 0.1 μg of Nb in 1 ml of solution. Iron in amounts of up to 200 μg does not interfere in the presence of ascorbic acid, as well as up to 25 μg of Ta, Zr, Tl, and Al (in the presence of complexone III). (auth)

30497 A GRAVIMETRIC METHOD FOR THE QUANTITATIVE DETERMINATION OF COLUMBIUM AND TANTALUM BY CYCLOHEXANONE EXTRACTION. Ya. G. Goroshchenko, M. I. Volkova, A. G. Babkin, and N. K. Pyryaev (Kola Branch, Academy of Sciences, USSR). Zh. Analit. Khim., 18: 739-42(June 1963). (In Russian)

A gravimetric method was developed for the quantitative determination of Nb and Ta by cyclohexanone extraction from aqueous solutions containing 400 g/l H_2SO_4, 200 g/l $(NH_4)_2SO_4$, and 100 g/l HF with subsequent back extraction of Nb from the organic phase by an aqueous solution containing 100 g/l H_2SO_4 and 50 g/l $(NH_2)_4SO_4$. By means of the method developed Nb and Ta may be determined in various materials containing more than 0.5 to 1.0% of pentoxides. Determination is hindered by P if the amount of P_2O_5 in the weighed portion of the original material exceeds 50 mg. The method is characterized by its universality and relative rapidity. (auth)

30498 SEPARATION OF PROTACTINIUM FROM OTHER ELEMENTS BY EXTRACTION WITH THENOYLTRIFLUOROACETONE. E. S. Palshin and B. F. Myasoedov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 18: 750-6(June 1963). (In Russian)

A study was made of Pa extraction with a 0.5 M solution of TTA in benzene from HCl, HNO_3, and H_2SO_4 solutions. It was found that Pa can be purified from Fe, Zr, Nb, U, Th, rare earths, and radioactive impurities of Bi, Po, and Th by Pa extraction from a solution 6 N in respect to HCl and 0.2 M in respect to $H_2C_2O_4$ and by its back extraction into the aqueous phase with a 0.25 M solution of oxalic acid. The effect of a number of elements on the extraction-photometric determination of Pa with TTA was also studied. It was established that large amounts of Fe^{2+}, Zr, Nb, Mn^{2+}, Al, U^{VI}, Th, and other elements do not interfere with Pa determination. (auth)

30499 TURBIDIMETRIC DETERMINATION OF SMALL AMOUNTS OF STRONTIUM. Yu. M. Rogosin (Leningrad Scientific-Research Inst. of Radiation Hygiene). Zh. Analit. Khim., 18: 777-9(June 1963). (In Russian)

A turbidimetric method is suggested for the determination of small amounts of Sr in solutions (5×10^{-5} to 5×10^{-3} N). The possibility of using the method for the determination of carrier amounts in radiostrontium preparations is also shown. (auth)

30500 A RAPID GRAVIMETRIC METHOD FOR THE DETERMINATION OF NIOBIUM IN THE PRESENCE OF LARGE AMOUNTS OF MOLYBDENUM. A. Ya. Sheskolskaya (Baikov Inst. of Metallurgy, Moscow). Zh. Analit. Khim., 18: 782-3(June 1963). (In Russian)

A rapid and precise method was developed for the quantitative determination of Nb in alloys with Mo without their separation beforehand. The method is based on Nb precipitation with cupferron at pH 4.6 in the presence of tartaric acid, which forms a complex compound with Mo. (auth)

30501 OPTICAL ANALYSIS OF URANIUM TETRAFLUORIDE CRYSTAL HYDRATES. S. S. Batsanov and Yu. V. Gagarinskii (Inst. of Inorganic Chemistry, Academy of Sciences, Novosibirsk, USSR). Zh. Strukt. Khim., 4: 387-94(May-June 1963). (In Russian)

Refractive indices and densities of two crystal hydrates, anhydrous uranium tetrafluoride, and eight specimens with various water content were determined and their molar refraction was calculated. The data were used for evaluating the water characteristics in the crystalline structure of uranium tetrafluoride crystal hydrates. In the $UF_4 \cdot 2.5\ H_2O$ the basic water part is bonded to fluoride by hydrogen; the rest is found in the U(IV) field. In the lower cubic syngony uranium tetrafluoride crystal hydrates all the water is combined with fluoride by hydrogen bond. The maximum water content does not exceed two moles per mole of UF_4. (R.V.J.)

30502 FLAME SPECTROPHOTOMETRIC DETERMINATION OF CESIUM AND RUBIDIUM IN OILFIELD WATERS. A. Gene Collins (Bureau of Mines, Bartlesville, Okla.). 20p. (CONF-14-10)

From American Chemical Society, 144th National Meeting, Los Angeles, Mar.-Apr. 1963.

A flame spectrophotometric method for determining Cs and Rb in oilfield waters, with a sensitivity permitting detection of less than 0.01 mg/l, was developed. Several solvents possessing high dielectric constants were evaluated for their ability to extract the tetraphenylboron complexes of Cs and Rb from oilfield waters, and for their emission characteristics. Nitroethane was selected and used for the extractions and flame spectrophotometric determinations. Radiotracer methods using Cs^{137} and Rb^{86} were employed to estimate the extraction efficiency. (P.C.H.)

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Refer also to abstracts 29959 and 30997.

30503 (CONF-14-5) CONVECTIVE MASS TRANSFER IN A DIAPHRAGM DIFFUSION CELL. John T. Holmes, Charles R. Wilke, and Donald R. Olander (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). Revised Feb. 12, 1963. Contract [W-7405-eng-48]. 15p.

From the American Chemical Society 144th National Meeting, Los Angeles, Calif., March–April 1963.

An experimental examination was made of the assumption for diaphragm diffusion cells that the resistance to mass transfer in the fluid regions adjacent to either side of the disk is negligible. The free- and forced-convection mass transfer characteristics of the vertical diaphragm cell were investigated and the results correlated in terms of stirrer speed and fluid properties. Data obtained indicated that cell constants obtained from calibration with dilute KCl or HCl at stirring speeds in the neighborhood of the critical speed will remain constant for most other solute-solvent systems of interest. However, if highly porous diaphragms or fluid systems of high viscosity and low diffusivity are employed, then the external mass transfer resistance may be an appreciable fraction of the resistance of the glass disc. (M.C.G.)

30504 (CONF-14-20) SOLVENT EFFECTS ON ASSOCIATION IN MOLTEN SALT SOLUTIONS. J. Braunstein, R. E. Hagman, and A. S. Minamo (Maine. Univ., Orono). [1962]. Contract [AT 30-1 -2873]. 4p.

From American Chemical Society, Los Angeles, March–April 1963.

The strength of association of the cations Ag^{+}, Pb^{2+}, and Cd^{2+} with halide ions in dilute solutions in molten alkali nitrate solvents was measured. The association constants for ion pair formation were measured potentiometrically, and the specific Helmholtz free energy of ion pair formation was evaluated from the equation of the quasi-lattice model. In mixtures of $NaNO_3$ and KNO_3, the size of the solvent effect and its approximate magnitude was in accord with the reciprocal Coulomb effect. In the $LiNO_3-KNO_3$ solvents, the solvent effect was not in the direction predicted by the reciprocal Coulomb effect. (M.C.G.)

30505 (CONF-14-22) TEMPERATURE AND PRESSURE DEPENDENCE OF ISOTOPIC EXCHANGE INVOLVING NITROGEN OXIDES. E. U. Monse, Lois Nash Kauder, and W. Spindel (Rutgers Univ., Newark, N. J.). [nd]. Contract [AT(30-1)-1018]. 37p.

From American Chemical Society Meeting, Los Angles, March–April 1963.

The exchange of N^{15} between N_2O_3 and NO was investigated. The sensitivity of the single-stage factor, α, toward changes in pressure and temperature is due to changes in the chemical composition of the system. Raising the pressure or lowering the temperature increases the N-isotope fractionation between the two phases. Measurements of α were carried out at −76°C and atmospheric pressure and at room temperature and pressures ranging from 2 to 9.5 atm. Results are presented in tables and graphs. At 23°C and 7 atm, α was found to be 1.030. (M.C.G.)

30506 (CONF-20-21) ORDER-DISORDER EFFECTS AND SOLID SOLUTIONS IN THE SYSTEM $NaF-YF_3$. R. E. Thoma, G. M. Hebert, H. Insley, and C. F. Weaver (Oak Ridge National Lab., Tenn.). [1962]. Contract [W-7405-eng-26]. 13p.

From 3rd Rare Earth Conference, Clearwater, Florida, April 1963.

Detailed investigations of $NaF-YF_3$ phase behavior showed that two intermediate equilibrium compounds are formed, $NaF \cdot YF_3$ and $5NaF \cdot 9YF_3$. Each compound occurs in two polymorphic forms with the high temperature form in both cases crystallizing from molten mixtures as fluorite-like cubic crystals. The two cubic phases form a continuous solid solution with a maximum melting temperature of 975°C at the composition $5NaF \cdot 9YF_3$. Lattice parameters and refractive indices of the solid solutions appear to be linear functions of the YF_3 content, a = 5.447 to 5.530 Å and refractive index = 1.430 to 1.473. Pure crystals of $NaF \cdot YF_3$ invert from the fluorite cubic form on cooling below 691°C to a hexagonal form which is isostructural with $\beta_2-Na_2ThF_6$, with lattice constants a = 5.95, c = 3.52 Å. In the temperature range 710 to 557°C, ordering takes place in the disordered saturated solid solution to produce a low temperature polymorph of the fluorite cubic compound, $5NaF \cdot 9YF_3$. The low temperature ordered form is distinguished by its superlattice and its optical birefringence. Solution behavior and ordering effects in the system $NaF-YF_3$ are of interest because of the apparent similarities in the uranium-oxygen system and in the rare-earth fluoride systems. (auth)

30507 (CONF-72-1) RECENT DEVELOPMENTS IN THE CHEMISTRY OF THE ACTINIDES AND LANTHANIDES IN MOLTEN NITRATE SALTS. W. T. Carnall (Argonne National Lab., Ill.). Contract W-31-109-Eng-38. 15p.

From Transplutonium Element Symposium, Argonne, Ill., May 1963.

Research on actinides and lanthanides in molten-salt systems is described. Possible solvent extraction under anhydrous conditions between organic extracts such as TBP and actinides dissolved in molten nitrate and a separation mechanism based on selective thermal decomposition were considered. An investigation is being made of the absorption spectra of the actinides and lanthanides in molten salt systems. (M.C.G.)

30508 (GA-3985) PITCH BINDERS FOR GRAPHITE: A SURVEY OF THE LITERATURE. J. R. Hooker (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Mar. 7, 1963. Contract AT(04-3)-167. 30p.

The general properties, composition, pyrolysis, and effect on molded graphite bodies of coal-tar pitch are reviewed. It was estimated that as many as 5000 different individual compounds are present in pitch in varying amounts. Practically all of them are in the same class, that of multiringed aromatic hydrocarbons. The majority of these are compounds of 3 to 7 rings with molecular weights ranging from 170 to 380 and are present as "associated colloids" or loosely bound aromatic clusters. An insoluble phase similar to carbon black is also present which, although it makes no direct contribution to the binding action, nevertheless influences the properties of both the pitch itself and the molded graphite products made with pitch. During the process of producing a graphite body from a filler-pitch-binder mix, the binder undergoes several heat-induced changes. Many of the conclusions on the mechanism of pitch pyrolysis were confirmed by studies on pure organic compounds known to be present in pitch. These studies included thermal stability, reactivity, differential thermal analysis, coke residue yields, and free-radical affinities. The relationship of the properties of the finished carbon or graphite body to the ingredients used, particularly the binder, was also reviewed. (M.C.G.)

30509 (HMI-B-25) THE KINETICS OF RARE-GAS DIFFUSION IN SOLIDS. TABLES AND GRAPHS FOR THE EVALUATION OF POST-ACTIVATION DIFFUSION EXPERIMENTS (RARE-GAS DIFFUSION IN SOLIDS 10). T. Lagerwall and K. E. Zimen (Hahn-Meitner-Institut für Kernforschung Berlin). June 1963. 37p.

The exact solution of the equation for the kinetics of diffusion of rare-gas atoms out of a crystal, where they were created by irradiation and nuclear reaction, was calculated with a digital computer in spherical, cylindrical, and rectangular symmetries for different crystal parameters. The results are presented in graphs and tables which permit a general and direct evaluation of post-activation-diffusion (PAD) experiments made with crystals of spherical form, and of any cylindrical or rectangular form. (auth)

30510 (IS-578) HIGH TEMPERATURE SPECTRAL EMISSIVITY OF YTTRIUM, SAMARIUM, GADOLINIUM, ERBIUM AND LUTETIUM OXIDES. W. R. McMahon and D. R. Wilder (Ames Lab., Ames, Iowa). Jan. 1963. Contract W-7405-eng-82. 48p.

Spectral emissivities are given for Y_2O_3, Sm_2O_3, Gd_2O_3, Er_2O_3, and Lu_2O_3 in the visible portion of the spectrum for temperatures up to 1600°C. The data were obtained using a carbon arc image furnace as an energy source, a photovoltaic cell as a radiation detector, a thermocouple as a temperature detector, and a magnesium oxide smoked plate as a standard of reflectance. Emissivity was calculated from a curve of combined reflectance and emitted radiation versus temperature by using Kirchoff's law and a method of successive approximations to solve Wien's equation. (auth)

30511 (NAA-SR-8235) ROLE OF Si, Al, AND OTHER IMPURITIES IN BeO CRYSTAL GROWTH. S. B. Austerman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1963. Contract AT (11-1)-Gen-8. 19p.

A number of impurities were considered and examined for their potential influence on the growth of BeO single crystals from molten lithium molybdate flux. The impurities considered were Mg, Ca, Al, Si, Mn, Zn, Cr, Fe, As, Sb, Te, Se, S, and F. Of these, only Al and Si were found to cause observable modifications in crystal habit and inclusion formation. It was concluded that analytical reagent grade MoO_3 and Li_2MoO_4, and nominally pure BeO, are adequately pure for the growth of BeO single crystals. (auth)

30512 (NLCO-880) HIGH TEMPERATURE VAPORIZATION STUDIES WITH THE BENDIX TIME-OF-FLIGHT MASS SPECTROMETER. R. W. Bonham, P. R. Morris, J. G. Nuckels, and A. D. Cavett (National Lead Co. of Ohio, Cincinnati). May 22, 1963. Contract AT(30-1)-1156. 9p. (CONF-40-1)

From Sixth Annual Conference on Vacuum Metallurgy, June 1963.

It was decided that the Bendix time-of-flight mass spectrometer could be used to monitor products of an effusion cell and thus provide the necessary data to study high-temperature reactions. The electron bombardment furnace is described. Studies of the high-temperature decomposition of uranium nitride and the reduction of uranium tetrafluoride with magnesium vapor are discussed. (M.C.G.)

30513 (ORNL-3471) THE ACTIVITY COEFFICIENTS OF HYDROCHLORIC ACID AND SODIUM CHLORIDE IN HYDROCHLORIC ACID–SODIUM CHLORIDE MIXTURES. M. H. Lietzke and R. W. Stoughton (Oak Ridge National Lab., Tenn.). July 29, 1963. Contract W-7405-eng-26. 10p.

The activity coefficients of HCl and NaCl in HCl–NaCl mixtures were computed from literature data. The calculations are based on the observation that at constant ionic strength and temperature the logarithm of the activity coefficient of HCl in HCl–NaCl mixtures varies linearly with NaCl concentration. (auth)

30514 (PG-Report-395) ANALYTICAL METHOD FOR THE MEASUREMENT OF POWDER SURFACE AREAS BY KRYPTON ADSORPTION. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 35p.

The method is suitable for the measurement of surface areas of samples, in the form of powders, using from 0.1 to 10 g of sample. The adsorbate used is krypton at the temperature of liquid nitrogen. The surface area is calculated from the normal B.E.T. equation. The method is suitable for the measurement of specific surface of powders over the range 0.005 to 10 m^2/g. At the 2 m^2/g level a standard deviation of ±0.05 was obtained over a long term trial by two operators. (auth)

30515 (TID-19012) THE COPRECIPITATION OF Sr^{+2} WITH CALCITE BETWEEN 90° AND 100°C. H. J. Holland (Princeton Univ., N. J.). [1963]. Contract AT(30-1)-2266. 35p.

$CaCO_3$ can be precipitated by the slow introduction of CO_2 into initially CO_2-free ammoniacal $CaCl_2$ solutions or by the slow release of CO_2 from ammoniacal $CaCl_2$ solutions which were initially in equilibrium with a vapor containing a high CO_2 pressure. Normally, calcite is the only or dominant polymorph of $CaCO_3$ in the precipitate, but aragonite may be present in small and occasionally in large amounts. The distribution of Sr^{+2} between solution and precipitate in calcite and aragonite was measured in precipitates prepared by both the CO_2 introduction and CO_2 release technique. The results are comparable. The value of the distribution coefficient k^C_{Sr} of Sr^{+2} between solution and calcite was found to be 0.076 ± 0.006. The distribution coefficient k^A_{Sr} of Sr^{+2} between solution and aragonite could not be measured precisely, but the values obtained are compatible with those reported previously (0.59 ± 0.02). The value of k^C_{Sr} is independent of both the ionic strength of the solution up to 1.4 m and of the mol fraction of Sr^{+2} in solution. It is probably also nearly independent of the NaCl concentration in the solutions from which it is precipitated. The value reported here can therefore be used to define the ratio $(m_{Sr} + 2/m_{Ca} + 2)$ in hydrothermal solutions from which calcite was deposited at 100°C. (auth)

30516 (TID-19080) SOFT X-RAY SPECTROSCOPY OF IRON, COBALT, NICKEL AND SOME ALLOYS AND COMPOUNDS OF IRON. Technical Report No. 16. K. Das Gupta (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). June 1963. Contracts AT(04-3)-221 and Nonr-220(30). 23p.

The K and L spectra of aluminum, the K spectra of silicon in second order, and the L spectra of iron, cobalt, and nickel were investigated in iron–aluminum and iron–silicon alloys. A bent crystal (mica and gypsum) and a ruled grating grazing incidence vacuum spectrograph were used. A prominent new 3d band structure was observed immediately on the short wavelength side of Lα of iron in alloys. (auth)

30517 (TID-19102) PRELIMINARY INVESTIGATIONS ON THE IONIC PROPERTIES OF STRONTIUM CHLORIDE. Anthony Taylor (Cornell Univ., Ithaca, N. Y.). July 10, 1963. Contract AT(30-1)-2471. 24p.

Single crystals of $SrCl_2$ were prepared by the Bridgeman technique from dehydrated analytical grade reagent care-

fully chlorine treated to remove OH^- groups. Ionic conductivity measurements over the temperature range 150 to 650°C using both a-c and d-c methods indicated that the lnσ vs 1/T curves resembled those obtained by Ure for CaF_2. From these data tentative values for the activation energy of anion motion and for the formation energy of a chlorine ion Frenkel pair were calculated. $SrCl_2$ crystals colored for 3 minutes with 120-kev x rays have optical absorption curves at room and at liquid nitrogen temperatures similar to those of other alkaline earth halides. In another test on the material, a suitably oriented specimen was tested in compression at room temperature and the flow stress in the [110] direction on the (100) plane was found to be 370 kg/cm^2. (auth)

30518 FERROELECTRIC TRANSITION FE_1-FE_2 IN $Pb(Zr_{0.65}Ti_{0.35})O_3$ CONTAINING 1 wt % Nb_2O_5. D. D. Glower and L. J. Overton (Sandia Corp., Albuquerque, N. Mex.). Appl. Phys. Letters, 3: 35-6(Aug. 1, 1963). (TID-18932; SCDC-3257)

The ferroelectric transition FE_1-FE_2 was observed in $Pb(Zr_{0.65}Ti_{0.35})O_3$ containing 1 wt % Nb_2O_5 at 105°C. This observation gives evidence that the boundary between the FE_1 and FE_2 ferroelectric phases previously reported for a Ti content <0.15 also exists for the content 0.35 and very probably exists until the rhombohedral-tetragonal phase boundary at 0.45. Resonant and antiresonant frequencies as well as maximum and minimum impedance were measured as a function of temperature. (C.E.S.)

30519 DISSOCIATION OF PROPANE MOLECULE IONS FORMED IN CHARGE EXCHANGE COLLISIONS WITH POSITIVE IONS. ION-MOLECULE REACTIONS OF PROPANE. E. Pettersson and E. Lindholm (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 24: 49-68(1963). (In English)

Mass spectra of propane were obtained after charge exchange with slow positive ions. The intensities of the peaks were plotted as a function of the energy absorbed by the molecule during the charge exchange. Integration of these curves gives a mass spectrum in good agreement with that obtained in electron impact. Ion-molecule reactions were observed at very low velocity (≈5 ev) of the incident ions. Proton transfer gives an ion that immediately dissociates by loss of CH_4 or H_2. The ionic complex $C_3H_5^+$ is analogous to CH_5^+ and C^+ is considered to have the valency five in both cases. Using this valency the dissociation processes are considered. (auth)

30520 THE ABSORPTION SPECTRUM OF $^{35}Cl_2$ FROM 4780 TO 6000 Å. A. E. Douglas, Chr. Kn. Moeller, and B. P. Stoicheff (National Research Council, Ottawa). Can. J. Phys., 41: 1174-92(July 1963). (NRC-7391)

The discrete absorption bands of gaseous chlorine that lie between 6000 Å and the dissociation limit, near 4780 Å, are photographed at high resolution with a 10-meter concave-grating spectrograph. This complex spectrum is simplified by the use of the separated isotopic species Cl_2^{35} and by cooling the cell. An analysis of all the strong bands is achieved. The principal constants of the ground state are found. (auth)

30521 PRECIPITATION AND HYDROLYSIS OF THORIUM(IV) IN AQUEOUS SOLUTION: THORIUM NITRATE–POTASSIUM HYDROXIDE. I. DETERMINATION OF SOLUBILITY CONSTANTS OF $Th(OH)_4$. H. Bilinski, H. Fueredi, M. Branica, and B. Težak (Univ. of Zagreb). Croat. Chem. Acta, 35: 19-30(1963). (In English)

The precipitation and hydrolysis of thorium (IV) in aqueous solutions of thorium nitrate–potassium hydroxide were investigated at 20°C with a tyndallometer and a pH meter. A three-dimensional precipitation diagram for a wide range of concentrations of both precipitating components was constructed. The concentration region of thorium hydroxide, the fast precipitation, and the formation of sols and of stable clear solutions were observed. The decreased precipitation of thorium hydroxide at pH 9 to 10.4 is considered to be the effect of the carbonate ions present. By a very simple graphical tyndallometric method the solubility products of thorium hydroxide were directly determined as: $\log \overline{K}_{S0} = 45.7$; $\log \overline{K}_{S1} = -24.3$ and the cumulative hydrolytic constant $^*\beta_2 = 1.029 \times 10^{-7}$ was calculated. The predominant hydrolytic species of thorium ion in aqueous solution in equilibrium with the solid phase of $Th(OH)_4$ were estimated. The predominant species is the free ion Th^{4+} for pH 3.4 and $[Th(OH)_2^{2+}]_n$ for the pH between 3.5 and 4.1. At values lower than pH 4.1 ionic species of thorium are formed with more than two OH^- ions per one thorium ion. (auth)

30522 PRECIPITATION AND HYDROLYSIS OF THORIUM(IV) IN AQUEOUS SOLUTION. II. INFLUENCE OF pH AND NEUTRAL ELECTROLYTES UPON THE PRECIPITATION IN THE SYSTEM THORIUM NITRATE–POTASSIUM PHTHALATE. H. Bilinski, H. Fueredi, and B. Težak (Univ. of Zagreb). Croat. Chem. Acta, 35: 31-42(1963). (In English)

The influence of the pH and other neutral electrolytes upon the precipitation and hydrolysis of thorium(IV) in aqueous solutions of thorium nitrate and potassium phthalate was investigated. A three-dimensional concentration tyndallogram in which turbidity has been plotted against the concentration of potassium phthalate and the pH, at constant concentration of Th(IV) 1.25×10^{-3} M, shows various precipitation and dissolution regions of the system. The following concentration regions were marked and discussed: the concentration region where sudden precipitation of thorium hydroxide occurs, the region of thorium hydroxide stable sols; the region of thorium phthalate sols; the region of unstable systems in which crystals appear after a few days' aging; and the region of the stable clear solution at rather high pH values. The effect of neutral electrolytes upon the precipitation in the region of stable clear solution was investigated. It was determined that neutral electrolytes influence to a great extent the precipitation at the boundary of thorium phthalate precipitate (pH = 5). (auth)

30523 ON THERMAL DECOMPOSITION OF NH_4UF_7. B. Volavšek (Inst. "Jožef Štefan," Ljubljana, Yugoslavia). Croat. Chem. Acta, 35: 61-6(1963). (In German)

Thermal decomposition of NH_4UF_7 connected with self reduction to UF_4 was studied in the temperature range of 100 to 450°C. From differential thermal analysis and thermogravimetric analysis, it was found that the thermal decomposition proceeds in three steps. Decomposition products were identified by x-ray powder diffraction photographs as α- and β-UF_5. Magnetic susceptibility measurements were also carried out in a temperature range of 186 to 295°K. (auth)

30524 ON THE SYNTHESIS OF XeF_8. J. Slivnik, B. Volavšek, J. Marsel, V. Vršćaj, A. Šmalc, B. Friec, and Z. Zemljič (Inst. "Jožef Stefan," Ljubljana, Yugoslavia). Croat. Chem. Acta, 35: 81-2(1963). (In German)

Conditions of xenon fluoride formation are studied, and the pressure of the reaction mixture Xe : F = 1 : 20 is measured in the temperature range between 20 to 620°C. In addition to previously reported XeF_6, a new reaction

product is observed. The fluorine analysis of this product corresponds to the formula XeF_8 (F:Xe ratio is 8.1 ± 0.1). In a sealed tube, at room temperature, this substance is an unstable pale yellow gas. By cooling, with liquid nitrogen the gas converts into a yellow solid phase. (auth)

30525 THE NATURE OF THE λ-TRANSITION AND THE PROPERTIES OF LIQUID HELIUM. G. Borelius (Royal Inst. of Tech., Stockholm). Cryogenics, 3: 96-103 (June 1963).

The current theories of the λ-transition of liquid helium are described, and it is proposed that the phenomena in the transition range are due to the intermediate structures between those of helium-II and helium-I. The thermodynamic properties of pure helium-II and helium-I are considered, and the properties of the intermediate states are then discussed in relation to the observed phenomena. The structure of the λ-particles is discussed briefly. (D.L.C.)

30526 THE PHASE DIAGRAM OF FREEZING HELIUM-3–HELIUM-4 MIXTURES. C. Le Pair, K. W. Taconis, P. Das, and R. de Bruyn Ouboter (Universiteit, Leiden). Cryogenics, 3: 112-14(June 1963).

Freezing and λ curves of He^3-He^4 mixtures were determined over the entire concentration range for pressures up to 50 kg/cm² at 0.5 to 2.0°K. Minima were found in the freezing curves, and the onset of phase separation was detected in the 50.5% He^3 mixture. The explanation of the results in terms of entropy is discussed. A T-X diagram is also presented; closed freezing lines were found at pressures below 25.9 kg/cm². The phase diagram is further complicated by phase separation and transition. (D.L.C.)

30527 THERMAL PROPERTIES OF CERTAIN LANTHANIDE SULFIDES. V. I. Marchenko and G. V. Samsonov (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Fiz. Metal. i Metalloved., 15: 631-3(Apr. 1963). (In Russian)

Interatomic distances and thermal expansion of LaS, La_2S_3, CeS, Ce_2S_3, PrS, Pr_2S_3, NdS, and Nd_2S_3 were studied at 20 to 1020°C. (R.V.J.)

30528 THE CALCULATION OF THE THERMODYNAMIC PROPERTIES OF DEUTERIUM. V. A. Rabinovich (Odessa Navy Inst.). Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 4, 118-22(Apr. 1963). (In Russian)

Laws governing the thermodynamic behavior of hydrogen and deuterium, which make it possible to use the equation of state of gaseous hydrogen for the calculation of the thermodynamic properties of deuterium, are considered. Results of calculations were compared with available experimental data. (auth)

30529 TEMPERATURE DEPENDENCE AND NATURE OF THE ELECTRON ABSORPTION SPECTRA OF URANYL COMPOUNDS. L. V. Volod'ko, A. N. Sevchenko, and D. S. Umreiko (Lenin Belo-Russian State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 651-5(May 1963). (In Russian)

Fluorescence (480 to 605 mμ) and absorption (390 to 495 mμ) spectra were determined for sulfuric acid solutions of uranyl and potassium uranyl sulfate and for ortho-phosphoric acid solutions of uranyl phosphate at temperatures from +20 to −183°C. In both spectra, lowering of the temperature was accompanied by significant narrowing of the bands and by a slight displacement of all spectra toward the short-wavelength region. As the sulfate solutions were cooled, the third band from the long-wavelength end in the absorption spectra separated into two components. The two spectra thus derived showed different temperature dependences of the absorption coefficient and are explained by a change from the basic electron condition to two excited states. The absorption capacity decreased greatly in this region. At −183°C the first two bands of the fluorescence and absorption spectra were almost identical. Mirror symmetry spectral plots showed that in the two derived absorption spectra the constancy of the frequency interval between bands is maintained, and the division of the intensity of absorption in the two spectra of each compound is almost identical with that of emission intensity in the fluorescence spectra. (TTT)

30530 REACTIONS OF ZIRCONIA AND TITANIUM AT ELEVATED TEMPERATURES. Robert Ruh (Wright-Patterson Air Force Base, Ohio). J. Am. Ceram. Soc., 46: 301-7(July 21, 1963).

The reactions between zirconia and titanium were studied by (1) weight change and bulk density determinations, (2) chemical analysis, (3) metallographic and petrographic analyses, (4) microhardness determinations, (5) lattice parameter measurements, (6) electron probe analysis, and (7) thermal conductivity determinations. These studies were made on specimens which had been fired in vacuum in the temperature range 1200 to 2000°C. Experimental data indicated that titanium contents up to 4 atomic % were retained at room temperature as a substitutional solid solution in zirconia. In titanium-rich binary alloys, zirconium and oxygen were retained in solid solution in titanium for zirconia contents up to approximately 10 mole %. In this case, the zirconium entered the titanium lattice substitutionally and the oxygen went into interstitial positions. (auth)

30531 DIELECTRIC BEHAVIOR IN THE SYSTEMS $PbHfO_3-BaHfO_3$ AND $PbHfO_3-SrHfO_3$. David L. Wilcox and Ralph L. Cook (Univ. of Illinois, Urbana). J. Am. Ceram. Soc., 46: 343-8(July 21, 1963).

An intermediate antiferroelectric phase was observed in both the systems (Pb, Ba)HfO_3 and (Pb, Sr)HfO_3 whereas the intermediate antiferroelectric phase has been reported to be observed only in the system (Pb, Sr)ZrO_3 of the analogous zirconate systems. A ferroelectric phase was observed in the system (Pb, Ba)HfO_3. This ferroelectric phase was determined to be rhombohedral with the angle between the rhombohedral axes slightly less than 90°. The differences which were observed between the hafnate systems investigated and the analogous zirconate systems are attributed to the lower electronic polarizability of the hafnium ion. (auth)

30532 THE STABILITIES OF $CoO \cdot Al_2O_3$, $CoO \cdot Cr_2O_3$, AND $2CoO \cdot SiO_2$. Egil Aukrust and Arnulf Muan (Pennsylvania State Univ., University Park). J. Am. Ceram. Soc., 46: 358(July 21, 1963).

The standard free energies of formation ΔG^0 of the mixed phases from their oxide components were measured at 1000 to 1350°C. A thermogravimetric technique was used in which pellets of the phases with excess sesquioxide were equilibrated in CO_2-CO gas mixtures. ΔG^0 was determined to be: $CoO \cdot Al_2O_3$, -6.9 ± 0.4 and -6.3 ± 0.4 kcal at 1000 and 1350°C; $CoO \cdot Cr_2O_3$, -11.2 ± 0.6 kcal at 1350°C; and $2\,CoO \cdot SiO_2$, -3.2 ± 0.3 and -2.8 ± 0.2 kcal at 1000 and 1300°C, respectively. (D.L.C.)

30533 SELF-DIFFUSION OF LEAD 210 IN SINGLE CRYSTALS OF LEAD SULFIDE AS A FUNCTION OF STOICHIOMETRY AND DOPING ADDITIONS. George Simkovich and J. Bruce Wagner, Jr. (Yale Univ., New Haven). J. Chem. Phys., 38: 1368-75(Mar. 15, 1963).

Self-diffusion of Pb^{210} in single crystals of lead sulfide

was studied in the temperature range 500 to 800°C. Measurements were made on undoped crystals and on crystals doped with Bi_2S_3 or Ag_2S under well-defined sulfur pressures and under an inert gas. Results show that increasing the cation vacancy concentration by means of excess Su or by Bi additions increases the diffusion coefficient, whereas decreasing the concentration of cation vacancies by means of excess Pb or by Ag additions also increases the diffusion coefficient over those of stoichiometric PbS. In all cases the electron concentration is accounted for according to: [interstitial lead atoms] $\propto p_{Pb}$/[excess electrons], and [cation vacancies] $\propto$ [excess electrons]/p_{Pb}, assuming singly ionized interstitial Pb atoms and singly ionized cation vacancies. The activation energies decrease in the order, stoichiometric PbS, lead excess PbS, and sulfur excess PbS. The results support a Frenkel disorder of the cation type. (auth)

30534 IDENTIFICATION OF COLOR CENTERS IN LITHIUM FLUORIDE. J. V. R. Kaufman (Picatinny Arsenal, Dover, N. J.) and C. D. Clark. J. Chem. Phys., 38: 1388-99(Mar. 15, 1963).

The optical absorption spectra induced in LiF by 2.0-Mev electron irradiation at a number of doses and at temperatures of 120 and 293°K were measured. The effects resulting from thermal and optical bleaching experiments on such specimens are described. A determined effort to color LiF additively was made. No induced absorption was observed between 1.0 and 6.0 ev. Anisotropic absorption was induced in the 4500-Å (2.76-ev) band by plane polarized 4047- and 4358-Å (3.06- and 2.84-ev) light at 293°K. The anisotropy was not affected by standing in the dark at 293°K. Results indicate that at least two absorption bands constitute the 4500-Å band, and it is suggested that one of these is the M band. It seems to have been generally accepted that the 2500-Å (4.948-ev) band in LiF is the F band, by analogy with the other alkali halides. However, the results show that analogies between results on LiF and the other alkali halides cannot be carried very far. (auth)

30535 ON IONIC CATALYSIS OF HYDROGEN-ATOM RECOMBINATION. John C. Light (Univ. of Chicago) and Kurt E. Shuler. J. Chem. Phys., 38: 1880-5(Apr. 15, 1963).

The feasibility of using hydrogen molecular ions, produced in a discharge, for the homogeneous catalysis of H-atom recombination in a second-order process was investigated. The catalytic cycle involves H_3^+ and H_4^+ ions and the efficiency of the H-atom recombination depends critically upon the stability of the H_4^+ ion complex against unimolecular decomposition. Rate constants for the various elementary reactions were calculated, and the limiting values of the rate constants for the second-order recombination reaction and for the catalytic efficiency were determined. It is shown that the detrimental loss of ions through electron–ion recombination can be minimized through sequential pulsed ionization. The results obtained indicate that hydrogen-atom recombination may be catalyzed effectively by molecular ions owing to the large reaction cross section of ion-atom reactions. The possibility of obtaining high catalytic efficiency of H-atom recombination with pulsed molecular ions of the type $(X_nH_m)^+$ would seem to warrant some extensive experimental studies. (auth)

30536 EVALUATION OF VAPOR-PRESSURE DATA FOR MERCURY, LITHIUM, SODIUM, AND POTASSIUM. W. T. Hicks (Univ. of California, Berkeley). J. Chem. Phys., 38: 1873-80(Apr. 15, 1963).

Vapor-pressure data for the elements mercury, lithium, sodium, and potassium were correlated using an equation of state, PV = RT + BP, where B was evaluated empirically with the relationship $B = b/T^m$. Values of B thus obtained are compared with values of the second virial coefficient calculated from a Lennard-Jones 6–9 potential curve. Calculated values for vapor pressures and fugacity-to-pressure ratios are presented for these elements as a function of temperature. (auth)

30537 YH_3 AND YD_3: HEAT CAPACITIES AND THERMODYNAMIC FUNCTIONS FROM 15° TO 350°K AND INFRARED ABSORPTION SPECTRA. Howard E. Flotow, Darrell W. Osborne, Klaus Otto, and Bernard M. Abraham (Argonne National Lab., Ill.). J. Chem. Phys., 38: 2620-6(June 1, 1963). (TID-18171; UAC-7102)

The heat capacities of YH_3 and YD_3 were determined in an adiabatic calorimeter from 15 to 350°K. The heat capacity, entropy, enthalpy, and Gibbs free-energy function for YH_3 at 298.15°K are 10.363 ± 0.021, 10.019 ± 0.020, 1613.3 ± 3.2 and –4.608 ± 0.009 cal/deg/mole, respectively. The corresponding quantities for YD_3 are 13.727 ± 0.028, 12.028 ± 0.024, 2024.8 ± 4.0, and –5.237 ± 0.010. The infrared absorption spectra of YH_3 and YD_3 were taken in the range 400 to 4000 cm^{-1}. Maxima in the absorption bands of YH_3 were observed at 1295, 920, and 640 cm^{-1} and in the absorption bands of YD_3 at $1295/\sqrt{2}$, $920/\sqrt{2}$, and $640/\sqrt{2}$ cm^{-1}. A reasonable assignment of the frequencies to Y-H and Y-D vibrations satisfactorily accounts for the difference between the heat capacities of YH_3 and YD_3 in the temperature range 50 to 350°K. The lattice parameters as determined by x-ray diffraction for the hexagonal close-packed trihydrides were $a_0 = 3.672 \pm 0.002$ Å and $c_0 = 6.625 \pm 0.018$ Å for YH_3 and $a_0 = 3.659 \pm 0.002$ Å and $c_0 = 6.586 \pm 0.019$ Å for YD_3. (auth)

30538 ON THE THERMODYNAMICS OF SOLUTIONS. IX. CRITICAL PROPERTIES OF MIXTURES AND THE EQUATION OF BENEDICT, WEBB, AND RUBIN. F. J. Ackerman and O. Redlich (Univ. of California, Berkeley). J. Chem. Phys., 38: 2740-2(June 1, 1963).

Values for the critical properties of gaseous mixtures derived from the equation of Benedict, Webb, and Rubin are not consistently better than those obtained from the equation of Redlich and Kwong. (auth)

30539 CRYSTAL-FIELD SHIELDING IN $PrCl_3$. Carl J. Lenander and Eugene Y. Wong (Univ. of California, Los Angeles). J. Chem. Phys., 38: 2750-2(June 1, 1963).

A calculation of shielding of the crystal field from the 4*f* valence electrons in Pr^{3+} due to the polarization of the outer $(5s)^2(6p)^6$ shell by the crystal field is reported. The effect is shown to be a principal constituent to the discrepancy of the experimental and theoretical values of the crystal-field parameters. (auth)

30540 RELAXATION TIME IN CO_2 AS A FUNCTION OF H_2 AND D_2 CONCENTRATION AT SEVERAL TEMPERATURES. T. G. Winter (Catholic Univ. of America, Washington, D. C.). J. Chem. Phys., 38: 2761-5(June 1, 1963).

The frequency of maximum ultrasonic absorption was determined for CO_2 with varying small amounts of the impurities H_2 and D_2 at three different temperatures. Hydrogen was found to be 2.4 times more effective than D_2 in quenching the vibration of CO_2 at both 47 and 154°C. More unexpectedly, it was found that the rate of shift of the frequency of maximum absorption with impurity concentration is less at high temperature than at low, and this fact is shown to imply that A-B collisions are 15 to 20% less

effective at the higher temperature than at the lower. The relaxing specific heat determined experimentally was found to be 5 to 8% greater than the spectroscopic value over the entire temperature range. (auth)

30541 DISSOCIATION ENERGY COMPUTATIONS IN DIATOMIC MOLECULES: AN EXAMPLE. Enrico Clementi (International Business Machines Corp., San Jose, Calif.). J. Chem. Phys., 38: 2780-2(June 1, 1963).

It is shown with a specific example that accurate dissociation energies in diatomic molecules can be computed without the need of exact wavefunctions but simply by comparing the self-consistent field energy of the diatomic molecules and the data on atomic correlation energy obtained thus far. The LiF molecule was used as an example. (P.C.H.)

30542 ON HYDRATION OF GADOLINIUM(III) IONS IN AQUEOUS SOLUTION. L. O. Morgan (Univ. of Texas, Austin). J. Chem. Phys., 38: 2788-9(June 1, 1963).

The results of a re-evaluation of proton relaxation data obtained from measurements on aqueous Gd^{3+} perchlorate solutions are presented. It is believed probable that the principal stable solution species for lanthanide 3+ ions vary across the series. (P.C.H.)

30543 EXPERIMENTAL STUDY OF THE ABSORPTION IN DISTILLED WATER, ARTIFICIAL SEA WATER, AND HEAVY WATER IN THE VISIBLE REGION OF THE SPECTRUM. Seraphin A. Sullivan (Catholic Univ. of America, Washington, D. C.). J. Opt. Soc. Am., 53: 962-8(Aug. 1963).

The absorption of light in distilled water, artificial sea water, and heavy water was measured in the visible region. A Nielsen spectrometer with glass optics was used with a tungsten source and photomultiplier detector. Path lengths were 60.0 and 132.0 cm. The absorption in distilled and artificial sea water differs little; maxima below 745 mμ were too weak to be observed. The absorption in heavy water is very small, increasing from a broad minimum at 700–600 mμ until at 390 mμ it is a factor of 10 larger than the minimum value. (auth)

30544 IONIC HYDRATION. Yolande Hendrikx. Mededel. Koninkl. Vlaam. Acad. Wetenschap., Belg., Kl. Wetenschap., 24: No. 4, 15p.(1962). (In Flemish)

Measurements were made of the transition of H_2O to D_2O and of D_2O to H_2O in two connected vessels of an apparatus containing an electrolyte in solution, through which an electric current was passed. The influences of diffusion and of exchange with the environment could be eliminated. Linear relationships between the ionic hydration numbers were obtained. In an apparatus of a different type the sum of the cationic and ionic hydration number of an electrolyte could be determined. Combination of these results with the linear relationships gave $h_{Cl^-} = 5$ (using LiCl and NaCl). If this value is introduced into the linear relationships, hydration numbers of the following ions were obtained: Li^+, Na^+, K^+, Cs^+; Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+}; and Cl^-, Br^-, F^-, NO_3^-, acetate, and sulfate. (auth)

30545 ANTI-SCREENING OF NUCLEAR QUADRUPOLE MOMENTS. A. G. Makhanek. Opt. Spectry. (USSR) (English Transl.), 14: 241-4(Apr. 1963).

On the basis of a general expression, Sternheimer antiscreening constants $\gamma_\infty(nl \rightarrow 1)$ were calculated for a number of ions. It was shown that there is a possibility of using experimental values of the dipole polarizability of ions and semiempirical values of the parameters $\langle r^{-3} \rangle$ to calculate $\gamma_\infty(nl \rightarrow 1)$. The values obtained for $\gamma_\infty(nl \rightarrow 1)$ were used for interpreting the nuclear quadrupole coupling constant in polar molecules and for determining the relaxation time in ionic crystals. The screening constants were calculated for certain ions on the basis of the Thomas–Fermi model. (auth)

30546 THEORY OF QUASI-LINE ELECTRONIC-VIBRATIONAL SPECTRA IN CRYSTALS. II. COMPARISON OF THE SHPOL'SKII EFFECT WITH THE MÖSSBAUER EFFECT. K. K. Rebane and V. V. Khizhnyakov. Opt. Spectry. (USSR) (English Transl.), 14: 262-3(Apr. 1963).

Attention is directed to the great similarity between the Shpol'skii and Mössbauer effects; a comparison of the two is presented. The Stokes losses play the same role in the Shpol'skii effect as the recoil energy plays in the Mössbauer effect. The analogy between the effects is particularly apparent if the influence of local vibrations is taken into account in the Mössbauer effect. (auth)

30547 DETERMINATION OF THE FORCE CONSTANT OF THE U–O BOND IN THE UO_2^{2+} ION. Yu. Ya. Kharitonov and Yu. A. Buslaev. Opt. Spectry. (USSR) (English Transl.), 14: 311(Apr. 1963).

The accuracy of determining the constants from the frequencies ν_1 and ν_3, considering the UO_2^{2+} ion as an isolated linear system and neglecting UO_2^{2+} ion interactions with ligands, is examined. The ν_3 frequencies for UO_2^{16}, $O^{16}UO^{18}$, and UO_2^{18} were taken from infrared absorption spectra. The frequency for UO_2^{18}, calculated from the UO_2^{16} frequency, disagreed with the observed UO_2^{18} frequency. The calculated force constants also exceed known force constants, indicating a 5% error arising from neglect of ligand-ion interactions. Lengths R_{UO} of the U–O bond derived from force constants calculated by this method agree well with values obtained by an x-ray method. (D.C.W.)

30548 MÖSSBAUER EFFECT IN Tm^{169} IN THULIUM IRON GARNET. R. L. Cohen (Bell Telephone Labs., Murray Hill, N. J.). Phys. Letters, 5: 177-8(July 1, 1963). (In English)

The nuclear hyperfine structure of the 8.4-kev transition in Tm^{169} in polycrystalline TmIG was studied. The measured absorption spectrum of TmIG at 78°K agreed in the central region, ±6 cm/sec, with that previously determined, but displayed new outer peaks at ±10 cm/sec. An explanation by which the absorption spectrum should consist of two six-line hyperfine spectra with equal intensities but different splittings is proposed and is used to analyze the data. Tm^{3+} ion moment and hyperfine interactions were obtained, and Tm sublattice magnetization values derived from the Mössbauer data are lower than those taken from bulk magnetization measurements. (D.C.W.)

30549 THE EFFECT OF TRACE AND DELIBERATELY INTRODUCED IMPURITIES OF THERMOLUMINESCENCE AND THERMAL BLEACHING OF F-CENTRES IN KCl CRYSTALS. S. C. Jain and P. C. Mehendru (National Physical Lab., New Delhi, India). Phys. Letters, 5: 186-8(July 1, 1963). (In English)

The thermoluminescence and thermal bleaching of quenched crystals of spectroscopically pure KCl, annular KCl (BDH), and KCl crystals doped with 1% by weight of Ca and Cd impurities were measured. The curve for pure crystals has peaks at 93, 165, and 230°C, while the BDH curve has peaks only at 80 and 157°C. The curve for Ca-doped crystal has peaks at 67 and 132°C; for Cd-doping, peaks occur at 77 and 107°C. The peaks are characteristic of the impurities and are reproducible. Measurements of thermal bleaching for the crystals also supported the idea that the rate of bleaching and hence the thermoluminescence

are not uniquely dependent upon the binding energy of the F-electrons but depend on other factors also. (D.C.W.)

30550 MÖSSBAUER DETERMINATIONS OF ISOMERIC SHIFT AND QUADRUPOLE SPLITTING IN SOME I^{129} COMPOUNDS. H. De Waard, G. De Pasquali, and D. Hafemeister (Univ. of Illinois, Urbana). Phys. Letters, 5: 217-20(July 1, 1963). (In English)

Strong recoilless resonance absorption of the 26.8 kev gamma line emitted after beta-decay of 70-min Te^{129} in absorbers of KI^{129}, $KI^{129}O_3$, $NH_4I^{129}O_3$, and $KI^{129}O_4$ was observed. The resonance absorption spectra of the iodide and the periodate each show a single line, whereas those of the iodates have a large quadrupole splitting. Values for the isomeric shift and the quadrupole moment (Q = −0.69 barns) of the 26.8-Mev state in I^{129} were derived from the spectra. (auth)

30551 NUCLEAR MAGNETIC RESONANCE OF POLYSTYRENE BASE SCINTILLATORS. E. E. Baroni, V. A. Ksenofontov, A. G. Kucheryaev, N. L. Oliferchuk, and Yu. A. Shuander (Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Strukt. Khim., 4: 459-60(May-June 1963). (In Russian)

Experimental studies were made of various properties of nuclear magnetic resonance of protons in polystyrene and plastic polystyrene scintillators. The temperature dependence of the wide component half-width was determined at +20 to 250°C in a 7000 g magnetic field. (R.V.J.)

30552 TEMPERATURE—ENTROPY CHARTS FOR GAS COOLED REACTOR COOLANTS (Engineering Materials). (Franklin Inst. Labs. for Research and Development, Philadelphia). (CAPE-883)

This package contains two charts. Gas-cooled power reactors that are now being built indicate higher operating temperatures are possible with gas coolants. The closed cycle permits higher pressures, more compact components, and the choice of gas other than air to serve as coolant. For higher temperatures, helium seems to be the desired coolant. Existing data on the thermodynamic properties of helium and molecular nitrogen had to be extrapolated. This was the main purpose of the temperature-entropy (T-S) charts. The Beattie-Bridgman equation of state was used for the extrapolation. The T-S charts were drawn both for helium and molecular nitrogen. (R.E.C.D.)

30553 STUDIES OF METAL OXIDE–METAL CHLORIDE-CHLOROCARBON CHEMICAL SYSTEMS. William Wendell Porterfield, Thesis, Chapel Hill, N. C., Univ. of North Carolina, 1962. 90p.

The reactions of various fully-chlorinated hydrocarbons, or chlorocarbons, with various metal oxides are investigated. Of these chlorocarbons, the most promising chlorinating agent, hexachloropropene, is studied in some detail. Four anhydrous metal chlorides, VCl_3, $NbCl_5$, $MoCl_5$, and WCl_6, can be synthesized in good purity and with great convenience using hexachloropropene. Four other metal oxides, Cr_2O_3, MoO_2, OsO_4, and Fe_2O_3, which react to produce compounds of less satisfactory stoichiometry are also described, with the attempts to characterize their products. Data for the metal oxides which do not react, B_2O_3, Al_2O_3, TiO_2, ZrO_2, ThO_2, Ta_2O_5, Co_3O_4, NiO, Sb_2O_5, MnO_2, and $KMnO_4$, together with a discussion of the synthetic limits of the reaction, are given. A study of the proposed separation of niobium from tantalum using the reaction of their pentoxides with hexachloropropene is described. No separation of chemically-mixed Nb_2O_5 and Ta_2O_5 is possible, and the reasons for the failure of the method are discussed. Using instrumental methods for the identification of the organic products of the reaction, a possible mechanism for the reaction which involves the reduction of the metal oxide during chlorination, is presented. Using pressurized reaction vessels, the reaction of hexachloropropene with several metal oxides not found to react at the normal boiling point of the liquid is examined at higher temperatures; one oxide which would not react previously, TiO_2, is shown to react completely to $TiCl_4$. Finally, a comparative survey of other chlorocarbons as chlorinating agents on MoO_3 is discussed and some possible avenues of future research proposed. (Dissertation Abstr., XXIII, No. 12(I))

30554 THE REACTIONS OF LANTHANUM WITH THE STRAIGHT CHAIN POLYPHOSPHATES. Richard Allan Baxter. Thesis, Philadelphia, Univ. of Pennsylvania, 1962. 126p.

The reactions between lanthanum and the simple straight chain polyphosphates were studied in aqueous solutions by means of pH and conductance measurements. The product of the reaction of lanthanum and orthophosphate is always the normal lanthanum orthophosphate regardless of the pH of the orthophosphate at the time of mixing. The nature of the precipitate was confirmed by elemental analysis and measurements based on the hydrogen ion displacement technique. Direct pH and conductance titrations of the species involved yielded inflection points which corresponded to the formation of the normal orthophosphate. No evidence was found for the existence of any soluble lanthanum orthophosphate complexes. The reactions of lanthanum with pyrophosphate were studied by the same techniques. The normal lanthanum pyrophosphate was found to be the precipitate formed. This precipitate was solubilized upon the addition of a large excess of the pyrophosphate. When a solution containing this soluble complex was allowed to stand for a period of two to three days, a second insoluble precipitate slowly crystallized out of solution. The infrared spectra of the two insoluble compounds showed conclusively that they were different compounds. The nature of the second precipitate was established by elemental analysis to be the double salt $La_4(P_2O_7)_3 \cdot Na_4P_2O_7 \cdot 10H_2O$. This was the only double salt formed regardless of the excess of pyrophosphate present. No insoluble double salt was formed when potassium pyrophosphate was substituted for sodium pyrophosphate. The reactions of tripolyphosphate, studied by the same techniques, showed that the normal lanthanum tripolyphosphate was formed. The potentiometric and conductance titrations showed a second inflection point which is related to the formation of soluble complexes. The stoichiometry of the complexes could not be established from these titrations since the inflection point corresponding to complex formation shifted with the initial concentration of lanthanum or tripolyphosphate. There was no evidence for the existence of an insoluble double salt. The reactions of tetrapolyphosphate were similar in most respects to those of tripolyphosphate. The normal lanthanum tetrapolyphosphate was the primary product. Soluble complexes were formed, but their identity could not be established since the inflection point corresponding to complex formation again varied with initial concentration. The initial drop in pH which occurs when a basic polyphosphate solution is added to a neutral lanthanum solution was studied. The drop in pH was found to be reproducible and to increase as the polyphosphate chain length increased. This drop in pH was attributed to the formation of basic lanthanum polyphosphate compounds.

On the basis of the potentiometric data and the work of other authors, it was assumed that complexes of the type $LaP_nO_{3n+1}^{-(n-1)}$ and $LaHP_nO_{3n+1}^{-(n-2)}$ are the predominant complexes formed. The stability constants of these complexes were determined from the pH data. Solutions of the polyphosphates containing various amounts of lanthanum were titrated automatically with standard acid and the changes in pH were recorded. The alkali metals were removed by means of ion exchange techniques. The method of calculation was based on the solving of simultaneous equations which expressed the conservation of the metal, polyphosphate and hydrogen originally present in the solution. The stability constants were found to increase with polyphosphate chain length. The stability constants of the 1 : 1 complexes were about three orders of magnitude greater than their monohydrogen counterparts. Lanthanum was also found to be suitable for use in an analytical method for the determination of orthophosphate and for polyphosphate chain length. (Dissertation Abstr., XXIII, No. 12(I))

30555 CONTROLLED POTENTIAL COULOMETRIC AND POLAROGRAPHIC INVESTIGATIONS OF METALLIC IONS IN FUSED SALTS. Roy Dudley Caton, Jr., Thesis, Corvallis, Ore., Oregon State Univ., 1963. 141p.

Two types of platinum(II)–platinum(0) reference electrodes used in fused lithium chloride–potassium chloride eutectic were compared and tested with respect to their stability with repeated use. One type was completely enclosed in a borosilicate glass tube, the glass serving as a salt bridge to the melt, whereas the other contained a small asbestos fiber sealed into the end of the glass tube. Both electrodes were found to be stable over long periods of time and capable of withstanding intermittent use for more than a year. Small drifts were noted, but such deviations were not significant when the electrodes were used for reference during controlled potential coulometric analyses which were performed in the melt. The controlled potential coulometric analysis of platinum, copper, chromium, and vanadium in fused lithium chloride–potassium chloride was studied. Platinum(II) analyses were performed with an average error of ±0.67 percent by plating out the metal on a platinum working electrode. Analyses of copper(I) solutions were performed with an average error of ±0.45 percent both by deposition of the metal and by stripping from a graphite or platinum electrode at controlled potential. Use of cylindrical electrodes with inert gas bubbling through the center of the cylinder provided efficient stirring and allowed electrolyses to be completed in four to five minutes. Chromium was determined with an average error of ±0.38 percent by reduction of chromium (III) to chromium(II) at a graphite electrode. Vanadium was determined by oxidation of vanadium(II) to vanadium (III) with an average error of ±1.0 percent. The presence of oxide ion contamination was found to seriously affect the vanadium determination due to deposition of vanadium (III) oxide at more negative potentials. Using a precise coulometric procedure, the standard electrode potentials of the vanadium(III)–vanadium(II) and chromium(III)–chromium(II) systems were determined in solutions ranging from 0.016 M to 0.04 M. The electrochemical behavior of niobium solutions in the lithium chloride–potassium chloride eutectic was studied by anodizing the metal in the melt and recording polarograms taken at a platinum microelectrode. Polarograms of solutions made by anodizing the metal exhibited two waves, the first of which was a composite wave involving a one-electron reduction step. Coulometric data obtained during the anodization of the metal and the relative heights of the anodic and cathodic portions of the composite wave indicated the presence of niobium(IV) and niobium(III) in the approximate concentration ratio of 3 : 1. The second wave appeared to be a two- or three-electron deposition process which was not clearly defined. The diffusion current of the first wave was found to be proportional to the amount of niobium dissolved in the melt. Polarographic studies of a series of metal oxides dissolved in fused alkali metaphosphates demonstrated the formation of several stable species which exhibited diffusion controlled current-voltage curves. Uranium(VI), copper(II), iron(III), and vanadium(IV) produced reduction waves involving two electrons for the uranium and one electron for the other metals. Sulfate ion was found to undergo a two-step reduction to sulfite ion and sulfide ion. Silver was the only metal found to deposit over the concentration ranges studied. (Dissertation Abstr., XXIII, No. 12(I))

30556 RARE EARTH OXIDE SYSTEMS. A STUDY OF THE REACTION OF OXYGEN WITH HEXAGONAL Pr_2O_3. Paul A. Faeth (Univ. of Michigan, Ann Arbor) and Alan F. Clifford. 22p. (CONF-20-16)

From 3rd Rare Earth Conference, Clearwater, Fla., Apr. 1963.

The rate of uptake of O by hexagonal Pr_2O_3 was measured between 927 and 985°C and at various pressures between 10 and 25 torr O. Measurements were made with the aid of a quartz beam microbalance and performed at constant temperature and pressure. The initial stage of the reaction exhibits an induction period during which time the uptake varies linearly with time. At longer times the kinetics are well described by a logarithmic (Elovich) expression. The constants of the logarithmic rate equation are pressure and temperature dependent, and their variation is described. A reaction well extends between ~300 and 900°C. Within the well region the reaction is extremely rapid over a wide range of pressures. A mechanism for the uptake, which involves a phase transition and a transfer of electrons and holes from the bulk to the surface, is postulated. (auth)

30557 ELECTRICAL PROPERTIES OF PRASEODYMIUM OXIDES. J. M. Honig, A. A. Cella, and J. C. Cornwell (Massachusetts Inst. of Tech., Lexington). 19p. (CONF-20-9)

From 3rd Rare Earth Conference, Clearwater, Fla., Apr. 1963.

Measurements of the resistance and Seebeck coefficients of praseodymia are reported for sintered pellets in the range 600 to 700°C as a function of the stoichiometry, and for single crystals in the composition range $PrO_{1.5}$ to $PrO_{1.831}$ as a function of temperature. The results are consistent with an electron-transfer model of a semiconductor in which neighboring cations in different valence states exchange electrons in the 4f shell. (auth)

30558 CATHODIC AND ANODIC PROCESSES DURING THE ELECTROLYSIS OF CHLORIDE AND FLUORIDE-CHLORIDE CONTAINING ZIRCONIUM AND HAFNIUM. M. V. Smirnov, A. N. Baraboskhin, V. E. Komarov, and N. A. Saltkova. p.257-65 of "Fizicheskaya Khimiya Rasplavlennykh Soley i Shlakov; Trudy Vses. Soveschch. po Fiz. Khimii Raspl. Soley i Shlakov, 22-25 Noyabrya 1960." Moscow, Metallurgizdat, 1962.

Investigations were made on electrode processes during the electrolysis of chloride and fluoride–chloride melts containing other polyvalent transition metals. Anodic and cathodic polarization curves were obtained by measuring the electrode potentials at the moment of switching on the

polarizing current. Polarization curves are presented for the anodic solution of Zr and Hf in molten equimolar mixtures of NaCl and KCl at 800°C, for a Mo cathode in NaCl–KCl melts to which specific amounts of $ZrCl_4$ (2.5 wt %) or $HfCl_4$ (3.6 wt %) were added at 800°C, and 0.9 wt % Zr was introduced by anodic solution of the metal at 900, 800, and 700°C, and for a Mo cathode in fluoride–chloride melts (at 800°C) prepared from NaCl–KCl melts by the addition of 2.8 wt % K_2ZrF_6 or 3.7 wt % K_2HfF_6 and the introduction of 0.95 wt % Zr by anodic solution of the metal and the addition of sufficient NaF to give molar ratios $[F]/|Zr| = 0$, 2, 6, 16, and 22 in the melts. The anode potentials increased continuously with increasing in current density (i) from 10^{-4} to 10 amp/cm^2. Below 3×10^{-3} amp/cm^2 concentration polarization was practically absent because the electrolysis current was lower than the self-solution (corrosion) current. In the range 3×10^{-3} to 1 amp/cm^2 the plots of electrode potential vs log i were nearly linear, but above 1 amp/cm^2 the curves deviate from linearity, owing mainly to the increase in metal ion concentration at the electrode surface and consequent increase in activity coefficient, but partly to change in the diffusion coefficient of the ions in the high concentration region and, thus, to change in the thickness of the diffusion layer. The anodic polarization curves shift to the side of more positive potentials with increase in temperature, but the general character of the dependence of the anodic potential on current density does not change substantially. For Zr at 800°, $E^0_{Zr^{4+}/Zr^{3+}} = -2.00$v, somewhat more positive than the potential at which the metal is liberated. For Hf at 800°C, $E^0_{Hf^{4+}/Hf^{3+}} = -2.14$v, more negative than the potential at which the metal is liberated. (TCO)

30559 ON THE PROBLEM OF SEPARATION OF TITANIUM FROM ZIRCONIUM. V. G. Bamburov and N. V. Demenev. p.124-31 of "Razdelenie Blizkikh po Svoystvam Redkikh Metallov. Mezhvuz. Konfer. po Metodam Razdel. Blizkikh po Svoyst. Red. Metallov." Moscow, Metallurgizdat, 1962.

Solubilities in the systems $KF-TiF_4-H_2SO_4-HF-H_2O$ and $KF-ZrF_4-H_2SO_4-HF-H_2O$ at 20°C with contents of H_2SO_4 of 5 wt % and HF of 1 wt % were studied for the purpose of determining the conditions for separating Ti and Zr from leaching solutions. The solubility of K fluorotitanate in the presence of 1.5% KF is 0.484% and that of K fluorozirconate is 4.460%. The ratio of the solubilities is 9.25. Optimum conditions for the separation of Ti and Zr by precipitation from solutions of their complex fluoride salts in a mixture of HF and H_2SO_4 in the presence of KF or a mixture of KCl and HF are: content of the salting out compound (KCl) 15.8 g/l; in this case 85.7% of Ti is precipitated, while 98.5% of Zr remains in the solution. The subsequent precipitation of Zr is done by further addition of the salting out agent. To prevent precipitation of Fe together with Zr, the addition is done at 80°C, when Fe is precipitated as $3KF \cdot FeF_3 \cdot 3H_2O$ and Zr remains in the solution. After filtering off the Fe salt, the filtrate is cooled to 18 to 20°C when K fluorzirconate is precipitated. The method of separation was checked on industrial solutions obtained in the process of fluoriding pyrochloric and sphenozirconic concentrates. The extraction of Ti and Zr amounted to 85.7 and 81.8%, respectively. (TCO)

30560 USE OF RADIOISOTOPE TECHNIQUES IN UNDERGRADUATE RESEARCH. M. Ann Elizabeth Waters (Dunbarton Coll. of Holy Cross, Washington, D. C.). 9p. (CONF-17-3)

From Oak Ridge Radioisotopes Conference, Applications to Physical Science and Engineering, Gatlinburg, Tenn., Apr. 1963.

Procedures followed in a study of the exchange of alkyl iodides with iodide ion using I^{131} as the tracer are described. The experiment was performed with n-butyl iodide, and the possible dependence of the reaction rate on chain length in a series of normal alkyl iodides was studied. Half-times and rates for C_4H_9I, $C_6H_{13}I$, $C_7H_{15}I$, $C_8H_{17}I$, $C_{10}H_{21}I$, and $C_{12}H_{25}I$ were determined. A small increase occurred in going from 1-iodobutane to 1-iodohexane. Results for 1-iodobutane in several solvents showed that the reaction rate increased with increasing solvent dielectric constant. (D.C.W.)

30561 INTERIOR FIELD MEASUREMENTS IN ILLUMINATED ADDITIVELY COLORED ALKALI HALIDE CRYSTALS. D. Grabenstein and D. Kahn. 8p. (CONF-23-4)

From American Physical Society Meeting, St. Louis, Mar. 1963.

An alternating voltage with frequency variable from 0.05 to 1000 cps is applied across two sides of a crystal, and a constant light source is directed against a third face. A pulsed light source that could be pulsed to coincide with any phase of the alternating voltage illuminated the fourth side. The internal field of the crystals is deduced from the electron current produced at the electrodes by the light pulses. The field in KBr fell off at a higher frequency than that in KI, which has a lower mobility. The results show that the interior field of an additively colored alkali halide crystal changes drastically with illumination and that at low frequencies the electrons excited into the conduction band are free to move. (D.C.W.)

30562 THERMODYNAMIC AND PHYSICAL PROPERTIES OF LIQUID FLUORINE AS CALCULATED BY SIGNIFICANT LIQUID STRUCTURE THEORY. Tom. R. Thomson, Henry Eyring, and Taikyue Ree (Univ. of Utah, Salt Lake City and Arizona State Univ., Tempe). 21p. (CONF-14-9)

From American Chemical Society, 144th National Meeting, Los Angeles, Mar.-Apr. 1963.

The theory of significant structures for liquids was applied to liquid F over the entire range from its melting point (53.54°K) to its critical temperature at 144°K, using only melting point data and such physical constants as atomic weight, moment of inertia, and the fundamental frequency of the molecule to find the essential parameters for the partition function. The following properties were calculated with reasonably good agreement with experimentally observed values: vapor pressure, density, surface tension, viscosity, compressibility, thermal coefficient of expansion, heat capacity at constant volume and constant pressure, entropy of vaporization, and critical temperature-pressure-volume. (auth)

30563 A THERMODYNAMIC STUDY OF NONSTOICHIOMETRIC α-Nb_2O_5 AND TiO_2. Robert Norman Blumenthal. Thesis, Evanston, Ill., Northwestern Univ., 1962. 105p.

The partial pressure of oxygen in equilibrium with a $NbO_2-Nb_2O_5$ mixture was determined from electrochemical cell measurements over the temperature range 800° to 1070°C and from thermogravimetric, gas-equilibrium measurements at 1000° and 1200°C. The results obtained from these measurements compared favorably with those obtained by previous investigators. An isopiestic technique was employed to determine the composition at 100°C intervals for the case of nonstoichiometric Nb_2O_{5-x} which was in equilibrium with NbO_2 between 900° and 1100°C.

The departure from stoichiometry for α-Nb_2O_{5-x} was found to decrease from $Nb_2O_{4.841}$ at 1090°C to $Nb_2O_{4.887}$ at 889°C. The partial pressure of oxygen in equilibrium with different compositions of nonstoichiometric Nb_2O_{5-x} was determined from electrochemical cell measurements over the temperature range 800° to 1070°C and from thermogravimetric measurements by equilibrating the nonstoichiometric Nb_2O_{5-x} specimen with a H_2/H_2O gaseous mixture at 900° to 1200°C. The results of these equilibrium measurements were compared with the results of the thermogravimetric study on nonstoichiometric Nb_2O_{5-x} by Kofstad and Anderson. A departure from the relation, composition $\propto p_{O_2}^{-\frac{1}{6}}$ determined by Kofstad and Anderson was observed in this study at the low oxygen pressure end of the homogeneous phase field, that is, near the oxygen pressure limits of nonstoichiometric Nb_2O_{5-x}. The relative partial molar enthalpy of oxygen, $\Delta\bar{H}_{O_2}$, for nonstoichiometric α-Nb_2O_{5-x} was found to be independent of temperature and composition within experimental error. The average value of $\Delta\bar{H}_{O_2}$ was –164 kcal. The relative partial molar entropy of oxygen, $\Delta\bar{S}_{O_2}$, for nonstoichiometric α-Nb_2O_{5-x} was found to increase negatively with increasing oxygen content. Electrochemical cell measurements and isopiestic experiments on specimens of titanium oxides indicated: the presence of a two-phase region in the range of O/Ti ratios from 1.968 to 1.991 at 1100°C, and the presence of a homogeneous phase region between $TiO_{1.992}$ and $TiO_{1.999}$. The results of this study indicate that the homogeneous rutile phase is stable over a much narrower composition range than has been suspected previously on the basis of either x-ray-diffraction studies or thermodynamic investigations. The partial pressure of oxygen in equilibrium with a mixture of nonstoichiometric TiO_{2-x} (rutile) and the next lower oxide of Ti was determined from electrochemical cell measurements over the temperature range 850° to 1070°C. The partial pressure of oxygen in equilibrium with different nonstoichiometric compositions of TiO_{2-x} (rutile) was determined from electrochemical cell measurements over the temperature range 900° to 1070°C. The composition (% wt. loss) for nonstoichiometric TiO_{2-x} was found to be related to the equilibrium partial pressure of oxygen, p_{O_2}, by the equation, $\log$ (% wt. loss) $\propto -1/5.2 \log p_{O_2}$. Using the law of mass action, the above experimental results may be rationalized on the basis of a defect structure involving quadruply ionized Ti interstitials. The possibility of the defect structure involving Ti interstitials triply ionized or oxygen vacancies either singly or doubly ionized instead of Ti interstitials quadruply ionized was considered. The relative partial molar enthalpy of oxygen, $\Delta\bar{H}_{O_2}$, for nonstoichiometric TiO_{2-x} was found to be independent of temperature and composition within experimental error. The average value of $\Delta\bar{H}_{O_2}$ was –211.3 kcal. The relative partial molar entropy of oxygen, $\Delta\bar{S}_{O_2}$, for nonstoichiometric TiO_{2-x} was found to increase negatively with increasing oxygen content. (auth)

30564 A PROCESS FOR THE PRODUCTION OF ALKALI METAL ZIRCONIUM SILICATES. (to Deutsche Gold- und Silber-Scheideanstalt Vormals Roessler). British Patent 924,811. May 1, 1963. Priority date Aug. 1, 1959, Germany.

A process for the production of alkali metal Zr silicates is patented, in which Zr silicate or a material containing Zr silicate is reacted with an excess of a solution of an alkali metal hydroxide. The reaction must take place in the presence of water at temperatures above 170°C and at elevated pressures. Best results have been obtained using sodium hydroxide and reaction temperatures above 200°C. The reaction mixture is diluted with water, and the alkali metal Zr silicate is removed by filtration. The filtrate can be concentrated and reused. (M.P.G.)

30565 PROCESS FOR PRODUCING ALKALINE EARTH METAL BROMITES. René Kircher and Robert Périat (to Société d'Etudes Chimiques pour l'Industrie et l'Agriculture). U. S. Patent 3,095,267. June 25, 1963. Priority date June 25, 1958, France.

Description is given of a process for producing new oxidizing agents in the form of certain solid, crystalline salts of bromous acid, which are easy to transport, and from which aqueous solutions as well as solutions in anhydrous organic solvents and in aqueous mixtures with organic solvents can be prepared that have new and specific oxidizing properties. The process is also used for producing alkali metal and alkaline earth salts of bromous acid, in solid crystallized form for use as the source of the oxidizing procedure and as brominating agents. A flowsheet for the process is given. (P.C.H.)

Organic Chemistry

Refer also to abstract 30406.

30566 (ORNL-TM-631) SYNTHESES OF SOME NEW MONO-ACID ESTERS. H. L. Holsopple (Oak Ridge National Lab., Tenn.). July 19, 1963. Contract [W-7405-eng-26]. 5p.

Eighteen mono-acid esters were prepared through cleavage of 6 cyclic anhydrides of dibasic acids (maleic, phthalic, succinic, 5-norbornene-2,3-dicarboxylic, 1-2-cyclohexane dicarboxylic, and tetrahydrophthalic) using three long-chained alcohols (dodecyl, tridecyl, and heptyldecyl). Methods are given for their preparation together with data obtained. (auth)

30567 THE PREPARATION OF RING-LABELLED TRITIATED NICOTINIC ACID BY EXCHANGE IN CONCENTRATED SULPHURIC ACID. J. M. Gumbley and A. T. Wilson (Victoria Univ. of Wellington, N. Z.). Biochim. Biophys. Acta, 74: 163-4(July 2, 1963). (In English)

A simple and convenient method is described for the preparation of large quantities of radiochemically pure tritiated nicotinic acid by exchange of the hydrogens of the pyridine ring in concentrated sulfuric acid. A product of sufficiently high specific activity for most purposes can be obtained after 3 to 5 weeks. (C.H.)

30568 SECONDARY HYDROGEN ISOTOPE EFFECTS. VI. ACETOLYSIS RATE OF CYCLOPENTYL-3,3,4,4-d_4 TOSYLATE. S. Borčić (Inst. "Ruder Boskovic," Zagreb). Croat. Chem. Acta, 35: 67-72(1963). (In English)

The synthesis of cyclopentyl-3,3,4,4-d_4 p-toluenesulfonate is described. The acetolysis rate constant of this compound at 50.0° was determined. With the help of the IBM 7090 computer a kinetic isotope effect (k_H/k_D) of about 0.95 was found to occur. This small rate increase is interpreted as possibly due to the +I effect of deuterium. (auth)

30569 MASS SPECTROMETRY IN STRUCTURAL AND STEREOCHEMICAL PROBLEMS. XXIV. A STUDY OF THE HYDROGEN TRANSFER REACTIONS ACCOMPANYING FRAGMENTATION PROCESSES OF 11-KETO STEROIDS. SYNTHESIS OF DEUTERATED ANDROSTAN-11-ONES. D. H. Williams, J. M. Wilson, H. Budzikiewicz, and Carl Djerassi (Stanford Univ., Calif.). J. Am. Chem. Soc., 85: 2091-2105(July 20, 1963).

Fifteen mono- or poly-deuterated analogs of 5α-androstan-11-one were synthesized with the label occurring in positions 1, 2, 3, 4, 5, 6, 8, 9, 12, and 17 and their mass spectra determined. As a result, it was possible to assign plausible representations to the principal mass spectral fragments and to examine the occurrence of hydrogen transfer reactions. These were found to be remarkably diverse and complicated, mechanisms being postulated for many of the fragmentation-cum-transfer processes. In the course of the synthetic work, it was possible to study in detail the enolization of 11-keto steroids, the ease of hydrogen abstraction proceeding in the order $9\alpha > 12\alpha \gg 12\beta$. (auth)

30570 ANIONIC ACTIVATION OF C–H BONDS IN OLEFINS. VI. INTRAMOLECULAR NATURE AND KINETIC ISOTOPE EFFECT OF BASE-CATALYZED OLEFIN ISOMERIZATION. S. Bank, C. A. Rowe, Jr., and A. Schriesheim (Esso Research and Engineering Co., Linden, N. J.). J. Am. Chem. Soc., 85: 2115-18(July 20, 1963).

The relative rates of double bond migration and of deuterium exchange of perdeuterio-1-pentene with unlabeled 2-methyl-1-pentene and solvent were determined at 55° in the system potassium tert-butoxide–dimethyl sulfoxide. It was found that isomerization is 16 times faster than exchange. The base-catalyzed prototropic migration is thus shown to be intramolecular. The relative rates of isomerization, activation enthalpies, and entropies of 1-pentene and perdeuterio-1-pentene were obtained. The values were compared with the values calculated for a primary isotope effect. The good agreement indicates that the carbon to hydrogen bond cleavage is largely complete in the transition state. The results are interpreted on the basis of a tightly bound ion pair. (auth)

30571 HYDROGEN ISOTOPE EFFECTS AND THE MECHANISM OF CYCLOADDITION. Thomas J. Katz and Ralph Dessau (Columbia Univ., New York). J. Am. Chem. Soc., 85: 2172-3(July 20, 1963).

The reaction of diphenylketene with 1-deuteriocyclohexene was examined to see whether a specific acid and ester were formed in significantly different amounts. The ester was isolated and the corresponding acid, mp 154 to 156°C, obtained by saponification, was analyzed. An observed excess of the ester indicated that, at the transition state determining the formation of the product, bond formation is not symmetrical (the bonds are not equally formed). The magnitude of the isotope effect (1.13 ± 0.03) was similar to the maximum secondary α-deuterium effect observed in numerous solvolytic, thermal cleavage, and addition reactions, in which the isotope effect was attributed to mass-sensitive changes in vibrational frequencies or steric crowding accompanying rehybridization of the carbon bearing hydrogen. (P.C.H.)

30572 LARGE STATISTICAL SECONDARY ISOTOPE EFFECTS IN NONEQUILIBRIUM REACTION SYSTEMS. UNIMOLECULAR DECOMPOSITION OF CHEMICALLY ACTIVATED ETHYL-$\underline{d}_1$ AND ETHYL-$\underline{d}_3$ RADICALS. J. H. Current and B. S. Rabinovitch (Univ. of Washington, Seattle). J. Chem. Phys., 38: 1967-73(Apr. 15, 1963).

Hydrogen atom rupture from chemically activated ethyl-$\underline{d}_1$ radicals was studied and is compared with a similar reaction of ethyl-$\underline{d}_3$ radicals. The activation reactions were D atom addition to ethylene or to trans-ethylene-$\underline{d}_2$. A very large normal statistical intermolecular secondary kinetic isotope effect of ≳1.5 per D atom substituent was found. The experimental results are in concordance with the theory and conform to the formulation of these effects previously given [B. S. Rabinovitch and J. H. Current, Can. J. Chem. 40: 557(1962)]. The calculated effect is ~1.6. These magnitudes per D atom are considerably enhanced over those obtained for butyl radicals. This is expected since the average excess energy of ethyl radical is less. (auth)

30573 ENERGY LOSSES IN NONREACTING COLLISIONS OF ENERGETIC RECOIL ATOMS: FAILURE OF THE ELASTIC COLLISION MODEL FOR TRITIUM REACTIONS IN CH_4-D_2 MIXTURES. John W. Root and F. S. Rowland (Univ. of Kansas, Lawrence). J. Chem. Phys., 38: 2030-2(Apr. 15, 1963).

Recoil tritium atoms were produced in gaseous mixtures of CH_4 and D_2, and the resulting mixture of DT, HT, and CH_3T was analyzed. The results show that the specific radioactivity of both molecules increases with mole fraction of D_2. The ratio of specific activities $(DT/D_2)/(CH_3T/CH_4)$, however, remains constant; this is consistent with the hypothesis that CH_4 is a better moderator, which is contrary to predictions of the elastic collision model. (D.L.C.)

30574 MICROWAVE SPECTRA AND STRUCTURES OF DIFLUOROETHYLENES. Victor W. Laurie and Dallas T. Pence (Stanford Univ., Calif.). J. Chem. Phys., 38: 2693-7(June 1, 1963).

The microwave spectra of the C^{12} and C^{13} species of cis-difluoroethylene-$\underline{d}_1$ and cis-difluoroethylene-$\underline{d}_2$ were investigated in the region of 8-36 kMC. Effective rotational constants for the ground vibrational state have been determined and are combined with previous microwave data to obtain the structural parameters: $r_{CC} = 1.324$ Å, $r_{CH} = 1.089$ Å, $r_{CF} = 1.335$ Å, ∢FCC = 122.1°, ∢HCC = 124.0°. The microwave spectrum of vinylidene fluoride was reinvestigated and the rotational constants for C^{13} species obtained. The data lead to a structure: $r_{CC} = 1.315$ Å, $r_{CH} = 1.079$ Å, $r_{CF} = 1.323$ Å, ∢FCF = 109.1°, ∢HCH = 121.8°. A comparison of the structures with data for vinyl fluoride and ethylene shows that fluorine substitution produces a systematic shortening of both the CC and CF bonds. (auth)

30575 SYNTHESIS OF D- AND L-2-AMINOBUTYLISOTHIOUREA DIHYDROBROMIDE ISOMERS AND THEIR CONVERSION TO GUANIDOTHIOLS, DISULFIDES, AND THIAZOLINES. David G. Doherty and Raymond Shapira (Oak Ridge National Lab., Tenn.). J. Org. Chem., 28: 1339-42(May 1963).

Optically active D- and L-2-aminobutyl bromide was prepared from the enzymatically resolved 2-aminobutyric acids, establishing their configuration. Condensation with thiourea yielded the D- and L-2-aminobutylisothioureas, which readily underwent a pH-dependent intramolecular rearrangement to give the D- and L-2-guanidobutane thiols or D- and L-4-ethyl-2-aminothiazolines. Oxidation of the thiols yielded the optically active 2-guanidobutyl disulfides. (auth)

30576 3-MERCAPTOPROPIONAMIDINE AND S-2-AMIDINOETHYL THIOSULFURIC ACID. Thomas P. Johnston and Anne Gallagher (Southern Research Inst., Birmingham, Ala.). J. Org. Chem., 28: 1436-7(May 1963).

The conversion of 3-mercaptopropionitrile (I) in several steps to 3-mercaptopropionamidine hydrochloride and S-2-amidinoethylthiosulfuric acid (inner salt) is reported. Protection of the mercapto group was achieved by the immediate iodine oxidation of freshly distilled I to 3,3'-dithiobispropionitrile. Structures were confirmed by infrared spectra. (P.C.H.)

30577 THE HYDROLYSIS OF β-DIETHYLAMINOETHYL ACETATE. J. A. Zaslowsky and E. Fisher (Olin Mathieson Chemical Corp., New Haven and Niagara Univ., Niagara Falls, N. Y.). J. Phys. Chem., 67: 959-61(May 1963).

The hydrolysis of β-diethylaminoethyl acetate was investigated over the pH range of 5.5 to 8.4. The data indicate that the hydrolysis proceeds by the interaction of the acid salt of the amine with hydroxyl ion rather than the kinetically equivalent mechanism involving the amine with water. This is explained on the basis of the polarization of the carbonyl bond of the ester by the favorably located positive charge. (auth)

30578 THE INFRARED SPECTRUM OF CH_3D. Flemming Allan Andersen. Kgl. Danske Videnskab. Selskab, Mat. Fys. Medd., 33: No. 12, 1-35(1963). (In English)

The infrared spectrum of CH_3D was measured in the region 400 to 6000 cm^{-1} by means of a prism instrument (Beckman IR3) of medium resolving power. The band-center frequencies were derived by rotational analysis of the fundamental bands. The results are compared with previous prism and grating data, and a slightly revised set of normal vibration frequencies is given. A value of the rotational content $A''(A_0)$ was obtained, which agrees within the limits of error with a recent Raman value. Coriolis coupling constants were derived for the three doubly degenerate fundamentals. Possible assignments of the observed combination bands are given. (auth)

30579 SYNTHESIS OF C^{14} LABELED ORGANIC COMPOUNDS ON A SMALL SCALE. M. Bubner. Thesis, Dresden, Technische Hochschule, 1962. 103p. $2.00.

A special method for synthesis of C^{14}-labeled organic compounds on a small scale is described. Provisions for radiation protection are discussed. Purification procedures for several labeled organic compounds are given. (Gmelin Inst.)

Radiation Chemistry and Radiochemistry

Refer also to abstracts 29897, 29899, 29901, 29902, 29903, 29904, 29905, 29906, 29907, 29908, 29909, 29910, 29911, 29912, 29913, 29914, 29915, 29916, 29917, 29918, 29919, 29921, 29922, 29923, 29924, 29929, 29930, 29931, 29932, 29936, 29937, 29938, 29939, 29940, 29941, 29942, 29943, 29944, 29945, 29946, 29947, 29948, 29949, 29952, 29960, 29962, 29964, 29970, 30040, 30041, 30042, 30046, 30047, 30048, 30049, 30081, 30120, 30126, 30132, 30135, 30136, 30138, 30139, 30140, 30141, 30142, 30145, 30146, 30153, 30154, 30155, 30162, 30163, 30166, 30167, 30168, 30191, 30192, 30193, 30194, 30195, 30196, 30197, 30198, 30199, 30200, 30203, 30206, 30207, 30210, and 30887.

30580 (AERE-M-1244) THE EFFECT OF IMPURITIES ON THE FAST NEUTRON ACTIVATION OF SULPHUR. S. J. Boot (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1963. 7p.

The thermal neutron activation of the impurities in disks of pure sulfur and sulfur-loaded rubber was determined by means of β decay and gamma spectrometry. The interference with the fast neutron flux measurements by the $S^{32}(n,p)P^{32}$ reaction caused by these activations was calculated for a short critical excursion of a solution of enriched uranium. It is shown that for the nominally pure sulfur disk, the impurity activation would be less than 1% of the P^{32} beta activity within one hour of the exposure. (auth)

30581 (BNL-796) HIGH-PRESSURE GAMMA LOOP FOR BROOKHAVEN NATIONAL LABORATORY. (Brookhaven National Lab., Upton, N. Y. and Burns and Roe, Inc., New York). June 1963. Contract AT-30-2-GEN-16. 131p. (BNL-T-305)

A feasibility and hazards study was performed in two phases: first, a preliminary design was made of a process system and equipment for the high-pressure gamma loop, and second, a conceptual design was developed for the test cells and gamma irradiation pool. The object of the proposed high-pressure gamma loop is to provide means of acquiring basic chemical and engineering information necessary for the use of gamma radiation as a standard unit operation. This goal is to be achieved first by study of radiation-induced polymerization of ethylene monomer to polyethylene, then by study of other reactions in the same facility. This facility, adequately housed and provided with the necessary personnel protection from radiation, high-pressure equipment and other process facility hazards, could be built for approximately $628,500 (not including test cells or gamma irradiation pool). Of this investment, $103,200 represents costs of equipment items which should not be charged directly to the high-pressure gamma loop experiment because these items are usable in other experiments and processes at Brookhaven National Laboratory. Thus, the net capital investment would be $525,300 for the process system and buildings. The test cells, gamma irradiation pool, and associated increased building volume and facilities would add $143,800 for a project total of $669,100. The work was concentrated on the polyethylene system. As far as practical, individual equipment items, the process itself, and the building were designed for maximum versatility to simplify conversion to other high-pressure radiation systems. The reaction vessel, heat exchangers, product receivers, and piping are suitable for many experiments; and the compressors can be used for many liquid as well as gaseous systems. The facility described is technically feasible. A facility based on the preliminary design described plus some development work on the reaction vessel and product separator is considered to be satisfactory in all respects. The purpose of the three test cells is to provide a facility for small-scale radiation processing and general irradiation experiments. The gamma irradiation pool can be used to store radioactive materials, and to perform standard gamma radiation experiments. The test cells, gamma pool, and related equipment are described. The design presented for the test cells is a manually operated mechanical system with provisions for optional electric operation. This arrangement was chosen because of its low cost and high reliability. The overall system has good versatility, and can be suited to a wide range of experiments. The three test cells, gamma pool, and related equipment will cost approximately $92,650, plus engineering and construction supervision charges. This cost does not include the lead shielding over the cells, the control consoles, and the flexible hose for the vent system. These items were not included in the estimate since they are standard equipment which may be used in other experiments and processes at Brookhaven National Laboratory and they will vary from experiment to experiment. There are no items in the test cell or gamma pool

which would require development before proceeding to final design, since the proposed system is essentially mechanical and is based on accepted design principles. However, areas that would require additional study are the test cell drainage system and the control console. The presented concept for the test cells and gamma pool does not pose any unique design or fabrication problems. The transition from concept to field erection should be smooth, and can be accomplished in a minimum of time. (M.C.G.)

30582 (IDO-14611) CHEMICAL PROCESSING TECHNOLOGY QUARTERLY PROGRESS REPORT, OCTOBER–DECEMBER 1962. J. R. Bower, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho). June 7, 1963. Contract AT(10-1)-205. 40p.

Aqueous zirconium fuel processing studies, directed at adapting the HF process to continuous dissolution-complexing to increase the capacity of the ICPP process, have led to a tentative recommendation for a flow-sheet change and minor equipment modification which will greatly expand the processing capacity. Basis of the change is use of a boron-containing hydrofluoric acid dissolvent which, through its neutron poisoning effect, will permit larger fuel charges in the existing dissolver. Machine calculations indicate adequate margins of safety within the solubility range of the boron compounds considered, and laboratory studies indicate no effect of the presence of boron on dissolution rate, uranium and solids behavior, or product solution composition. Bench scale and pilot plant runs on scaled-down equipment indicate that the flow-sheet is feasible and should provide the required capacity for currently anticipated fuel receipts. Criticality studies of the system are continuing. Other zirconium fuel processing studies indicate the possible usefulness of a dissolution reagent of ammonium bifluoride-triethanolamine which will dissolve zirconia at a usable rate and still not attack zirconium metal at an undesirably rapid rate as does molten ammonium bifluoride. Electrolytic dissolution studies have led to the design and construction of a pilot model dissolver to operate, through use of interchangeable components, as either a solution-contact or basket-contact dissolver for stainless steel fuels. Electrolytic dissolution of aluminum in the acid-deficient range was demonstrated as potentially attractive because of the high concentration of aluminum achieved and resulting decreased volume of waste to be stored. Aluminum-uranium alloy was dissolved to a concentration of 3.6M aluminum and 5.6M acid deficiency without the accompanying precipitate problem associated with the nitric acid-mercury catalyst process. Summaries are presented of reports issued on metal-contact basket dissolver studies, dissolver product analysis, and dissolver product properties. New waste-treatment studies involving the removal of activity from the fuel storage basin water, which has become contaminated from corroded and damaged fuel elements, have led to the decision to install disposable filter cartridges consisting of a local natural mineral, clinoptilolite, packed in 55-gallon drums. Approximately 1000 volumes of water may be passed through a given volume of clinoptilolite before a one percent breakthrough of strontium occurs; a one percent breakthrough of cesium occurs only after 4500 volumes throughput. The new melt-freeze process for reducing waste volumes by separation of inert solid aluminum nitrate from the radioactive constituents in aqueous aluminum fuel wastes is being studied in a newly installed four-stage laboratory unit. The ICPP Waste Calcining Facility underwent a successful 700-hour run during which two radioactive sodium tracer spikes were added to the fuel. Quantitative material and activity balances indicated excellent performance of the off-gas cleaning system; solids emission from the stack (based on activity analysis) was found to be equivalent to approximately $^{1}/_{13}$th that required to meet the tentatively established limit for release of activity during processing of standard ICPP wastes. Process control was excellent; remote operation, with access to the cells restricted, created no problems. Other calcination studies reported include specific equipment performance, pilot plant studies on solids carry-over and particle-size control, and laboratory studies on phase transformations in calcination of various components of the waste feed. Additional basic process studies reported include use of a capacitance probe for determination of liquid level and amplitude in an air-pulsed column and evaluation of column operation by interface control and organic feed rate control. (auth)

30583 (MLM-1158) RADIOACTIVE IMPURITIES IN THE POLONIUM PROCESS AT MOUND LABORATORY. Robert C. Lange (Mound Lab., Miamisburg, Ohio). June 3, 1963. Contract AT(33-1)-Gen-53. 11p.

Radioactive impurities in the polonium process at Mound Laboratory were investigated radiochemically. Tellurium and, to a lesser extent, selenium were found to be the radioactive impurities in the polonium product. At least 30 days' cooling time is recommended for the irradiated bismuth in order to avoid greater-than-tolerance amounts of Po^{210} in waste solutions. Specifications for bismuth feed material are being evaluated to include maximum permissible concentrations of selenium and tellurium. (auth)

30584 (TID-18955) STUDIES IN NUCLEAR AND RADIOCHEMISTRY. Report for the Period May 1, 1962–April 30, 1963. Rolfe H. Herber (Rutgers Univ., New Brunswick, N. J. School of Chemistry). Contract AT(30-1)-2472. 46p.

Results of research concerned primarily with hot atom chemistry, isotopic exchange reactions, and chemical exploitation of the Mössbauer Effect are reported. Although significant progress was made in each of these areas, the main emphasis of this research has been on the Mössbauer Effect. The effects of K-capture in organocobalt compounds and the effects of neutron and gamma irradiation on SnO_2 were studied. In the field of exchange kinetics, the system $(HBNCl)_3-BCl_3$ was studied using Cl^{36} as a tracer. A method for the preparation of radiochlorine-labeled chloroborazole was developed as was a technique for studying the homogeneous exchange in the gas phase at 90°C. The resonant gamma absorption spectra of a large number of organoiron compounds were obtained using a parabolic motion drive and multichannel analyzer computing system. A new systematics of isomer shifts in these compounds was suggested, and a number of correlations with molecular structure and chemical bonding now appear fruitful in terms of their predictive and analytical value. A simple method for preparing sharp-line Mössbauer sources was developed, and a precision determination of the Cr–Cu isomer shift was made. (auth)

30585 ON THE DEPENDENCE OF RADIOLUMINESCENCE EFFICIENCY ON THE AVERAGE MOLECULAR WEIGHT OF POLYSTYRENE SCINTILLATORS. Z. Polacki (Technical Univ., Gdansk, Poland). Acta Phys. Polon., 23: 589-600(Mar. 1963). (In English)

Measurements cover the dependence of the relative technical efficiency of radioluminescence of polystyrene scintillators on the average molecular weight of the polymer. Since luminophors were found to affect the polymerization process, only the intrinsic viscosities to which the average molecular weight of the plastic mass is propor-

tional are given. Radioluminescence efficiency was found to rise with decreasing intrinsic viscosity; this is explained by an increase in energy efficiency of the luminescence of polystyrene as the latter's average molecular weight decreases. (auth)

30586 THE X-RAY-INDUCED ELECTRIC CONDUCTIVITY IN THE PVC PLASTIC "TROVIDUR." Leonard Wojtech (Max-Planck-Institut für Biophysik, Frankfurt am Main). Biophysik, 1: 60-72(1963). (In German)

In the plastic "Trovidur," a product based on polyvinyl chloride, the change of conductivity with irradiation at high doses was investigated. During the irradiation at doses from 3.5×10^3 to 3.8×10^5 rad/min, the dependence between the radioinduced current i and the dose rate L could be established. The specific conductivity after irradiation with 3.8×10^5 rad/min increased by a factor of 1.3×10^4 from 8×10^{-19} ohm^{-1} cm^{-1} to 1×10^{-14} ohm^{-1} cm^{-1}. (M.C.G.)

30587 RADICAL DECAY AND COLOR FORMATION AT VARIOUS TEMPERATURES IN UNPLASTICIZED POLY(VINYL CHLORIDE) IRRADIATED IN VACUO AT 25°C. G. J. Atchison (Dow Chemical Co., Midland, Mich.). J. Appl. Polymer Sci., 7: 1471-85(July 1963).

Moldings were irradiated at ambient temperatures in vacuo with 2 Mev electrons to doses of 5.9 to 7.3 Mrad. The decay of radicals was followed by EPR spectroscopy at 80, 55, and 30°C while simultaneous extinction measurements were made at 300 to 700 mμ with a recording spectrophotometer. The radical decay data indicated the presence of three species at each temperature, decaying exponentially with time, with half lives of 20 min, 210 min and 135 hr at 80°C, of 40 min, 400 min, and 141 hr at 55°C, and of 54 min, 720 min, and 3200 hr at 30°C. G values of 1.6, 2.0, and 1.4 were obtained for radical formation at 25°C by back-extrapolation of decay curves from the three temperatures to the end of the irradiation period. The activation energy of radical decay was found to be 4.4, 5.0, and 13.7 kcal/mole for the short-lived, intermediate-lived, and long-lived radicals, respectively. The optical data has a broad absorption maximum of 500 to 550 mμ and a series of seven absorption peaks with maxima at 505–510, 483–485, 458–460, 430–435, 400–405, 364–365, and 329–330 mμ. The concentration of the material producing the broad bands was found to be inversely proportional to the long-lived radical concentration. The fine-structure peaks are consistent with literature data for a polyene chain of 16 to 17 conjugated double bonds. (auth)

30588 ELECTRON PARAMAGNETIC RESONANCE ABSORPTION STUDIES OF NEUTRON-IRRADIATED α,α-DIPHENYL-β-PICRYL HYDRAZINE. Y. W. Kim and P. W. France (Wayne State Univ., Detroit). J. Chem. Phys., 38: 1453-4(Mar. 15, 1963).

The possibility of forming molecules of α,α-diphenyl-β-picryl hydrazyl (DPPH) in α,α-diphenyl-β-picryl hydrazine ($DPPH_2$) by irradiating $DPPH_2$ is discussed. Samples of $DPPH_2$ were irradiated at room temperature in beams of thermal neutrons with doses from 1.20×10^{14} to 1.44×10^{17} nvt. EPR absorption in dilute liquid solutions of irradiated solutions of $DPPH_2$ exhibited a very close similarity with EPR absorption in dilute liquid solutions of DPPH. (P.C.H.)

30589 ANALYSIS OF ESR SPECTRA OBSERVED IN IRRADIATED AROMATIC SYSTEMS. R. B. Ingalls (Atomics International, Canoga Park, Calif.) and D. Kivelson. J. Chem. Phys., 38: 1907-9(Apr. 15, 1963).

Several structures have been proposed to explain the large hyperfine splittings observed in aromatic systems which have been exposed to ionizing radiation or hydrogen-atom bombardment. The observed extra hyperfine structure was used to obtain electron densities on the various carbon atoms of the cyclohexadienal radical, and McLachlan's treatment was applied to calculate the splitting of the two hydrogen atoms on the single carbon atom of the C_6H_7 radical. The calculated values are in satisfactory agreement with the 45- to 50-G splitting between lines of the observed triplet. The other proposed structures are shown to be unlikely to produce such large splittings, or not applicable to purely aromatic systems. (auth)

30590 ESR STUDIES ON IRRADIATED FROZEN AQUEOUS SOLUTIONS OF SULFUR COMPOUNDS. Thormod Henriksen (Norsk Hydro's Inst. for Cancer Research, Oslo). J. Chem. Phys., 38: 1926-33(Apr. 15, 1963).

Radiation-induced ESR centers in frozen aqueous solutions of sulfur compounds were studied. Special attention was focused on secondary radical reactions and the relative importance of direct and indirect effects. Solutions were rapidly frozen at 77°K and irradiated in vacuum at this temperature. All ESR spectra were recorded at 77°K. The irradiated samples were heat treated, either for increasing lengths of time at 110°K, or for the same period of time at successively increasing temperatures. The ESR spectra of aqueous solutions irradiated at 77°K are composed of the "water resonance" and a resonance ascribed to radicals in the solute. The latter are found primarily to be induced by the direct action of radiation. This observation implies that H atoms which already have reacted at 77°K have no or very little effect in producing solute radicals. The remaining ESR centers in water, including OH radicals, are released in the temperature range 100 to 130°K. The spectral changes in this temperature range indicate that recombination processes dominate and only a minor fraction of the "water radicals" interacts with the solute. Thus, in a 10% solution of glutathione, about 15% of the "water radicals" become effective in producing solute radicals. The radicals induced in the solute and the subsequent secondary radical reactions seem to be more or less the same as those found when the solute was irradiated in the solid state. For solutions of some simple thiols like penicillamine the secondary reactions yield sulfur radicals above 170°K, in accordance with the results for solid penicillamine. On the other hand, no sulfur resonance appears for solutions of glutathione in spite of the fact that sulfur radicals are formed in the solid state. The resonance of the solution disappears at a lower temperature than that found necessary for the formation of sulfur radicals in solid glutathione. (auth)

30591 RADIATION DECOMPOSITION OF AQUEOUS AZIDE SOLUTION CONTAINING MERCURIC SALTS. Kenichi Shinohara (Inst. of Physical and Chemical Research, Tokyo), Tadamasa Shida, and Nobufusa Saito. J. Chem. Phys., 38: 1985-90(Apr. 15, 1963).

The addition of mercuric salts causes a marked change in the radiolytic reactions of aqueous azide ion solution. Hydroxyl radicals and hydrogen atoms are scavenged by the azide ion and mercuric salt, respectively. In order to explain the high yields of nitrogen and mercurous azide in terms of the current theory of water radiolysis, it is suggested that the excited water molecule which might be formed by primary recombination between the H_2O^+ ion and the ejected electron, and by slow electron collision in spur, may be involved. The excited water molecule is assumed tentatively to be a triplet and to behave like a diradical, which with an azide ion gives a comparatively long-lived complex $(N_3^-H_2O)_{(triplet)}^*$. The previous results

of the radiolysis of pure azide ion solution were discussed in terms of this new assumption. (auth)

30592 ISOTOPE EFFECT IN THE IONIZATION OF POLYATOMIC GASES BY BETA PARTICLES. William P. Jesse (St. Procopius Coll., Lisle, Ill.). J. Chem. Phys., 38: 2774-5(June 1, 1963).

Experiments were carried out to determine whether an isotope effect could be found in the photo-ionization of deuterated and undeuterated methane, ethane, and ethylene. A measurable difference was found between the ionization observed for beta particles in the deuterated and undeuterated gases, which was of the order of 1%. (P.C.H.)

30593 SOME REMARKS ON THE NATURE OF IONIZATION, IONIZATION YIELDS, AND ISOTOPE EFFECTS IN THE IONIZATION OF MOLECULES BY VARIOUS AGENCIES. Robert L. Platzman (Argonne National Lab., Ill.). J. Chem. Phys., 38: 2775-6(June 1, 1963).

Isotope effects in the photo-ionization of molecules are discussed. An isotope effect in the cross section for ionization by charged particles is also predicted. (P.C.H.)

30594 SOME GAS-PHASE REACTIONS OF HOT AND THERMAL ATOMIC FLUORINE. Neville Colebourne and Richard Wolfgang (Yale Univ., New Haven). J. Chem. Phys., 38: 2782-3(June 1, 1963).

A study was made of the gas-phase reactions of hot fluorine atoms. Trace quantities of F^{18} (112 min), produced by the $F^{19}(\gamma,n)F^{18}$ nuclear recoil process, were used as the source of atomic fluorine. Carbon tetrafluoride served as both the reactant gas and the source of target F^{19}. The gas was exposed to a bremsstrahlung beam of 40 to 60 Mev electrons at 25°C for a period of 2 hr. With pure CF_4, F^{18}-labeled CF_4 and C_2F_6 were found. On the addition of about 1 mole % C_2H_4 to the CF_4, a major fraction of the F^{18} appeared as a constant yield of $C_2H_3F^{18}$ and an irreproducible yield of $C_2H_5F^{18}$. When ethylene and iodine at its vapor pressure at 25°C were present, the $C_2F_5F^{18}$ and $C_2H_5F^{18}$ disappeared, and reproducible yields of $CF_2F^{18}I$ and $C_2H_4F^{18}I$ appeared instead. (P.C.H.)

30595 ON THE CHEMISTRY OF NATURAL RADIOCARBON. Colin MacKay, Mary Pandow, and Richard Wolfgang (Yale Univ., New Haven and Haverford Coll., Penna.). J. Geophys. Res., 68: 3929-31(July 1, 1963).

Detailed studies with C^{11} atoms of high kinetic confirm that natural radiocarbon initially reacts in the atmosphere to form CO. In accord with this, several samples of atmospheric CO show a specific activity much higher than would be expected from the predominantly fossil fuel origin of this gas. (auth)

30596 ADDITION REACTIONS INDUCED BY IONIZING RADIATION. I. BROMOTRICHLOROMETHANE TO BUTADIENE. Catherine S. Hsia Chen and Robert F. Stamm (American Cyanamid Co., Stamford, Conn.). J. Org. Chem., 28: 1580-5(June 1963).

The addition reaction of bromotrichloromethane to butadiene induced by ionizing radiation was studied. The products were characterized, and their stereoconfigurations were determined by means of infrared and Raman spectroscopy. The kinetics were investigated over the temperature range 25 to 40°; the dose rates ranged from (1.4 to 6.5) × 10^3 rads/min, and the mole ratio of bromotrichloromethane–butadiene was varied from 1:1 to 46:1. It was observed that the adducts obtained were primarily 1,4-trans. The reactions are free radical chain reactions as evidence by the G values (200 to 800 molecules/100 ev), by the dose rate dependences (rate $\propto I^{0.5}$; G $\propto I^{-0.5}$), and by a positive activation energy (ΔE_a = 5.5 kcal/mole). It also was found that the reaction is zero order in butadiene. (auth)

30597 ADDITION REACTIONS INDUCED BY IONIZING RADIATION. II. BROMOTRICHLOROMETHANE TO ISOPRENE AND 2,3-DIMETHYLBUTADIENE. Catherine S. Hsia Chen and Evalyn F. Hosterman (American Cyanamid Co., Stamford, Conn.). J. Org. Chem., 28: 1585-9(June 1963).

For comparison with the addition of bromotrichloromethane to butadiene induced by ionizing radiation, similar reactions involving isoprene and 2,3-dimethylbutadiene were investigated. In the isoprene reaction using three moles of bromotrichloromethane to isoprene, the 1:1 adduct was shown to contain products resulting from 72% 1,4-addition, 26% 4,1-addition, and a small amount of 1,2- and 4,3-additions. In the 2,3-dimethylbutadiene reaction, in all mole ratios studied, the product obtained was exclusively the 1:1 adduct resulting from 1,4-addition. Kinetics of the reaction were investigated over the temperature range 25 to 40°; the dose rate ranged from (1.4 to 6.3) × 10^3 rads min^{-1}; and the mole ratio of bromotrichloromethane:diene was varied from 1:2 to 19:1. It was observed that 2,3-dimethylbutadiene was the most reactive among the three dienes. The activation energies were 3.96 kcal/mole for isoprene and 3.09 kcal/mole for 2,3-dimethylbutadiene. The G values (molecules of diene consumed/100 ev absorbed) ranged from 450 to 1000 for isoprene and 1000 to 3650 for 2,3-dimethylbutadiene. The dose rate dependences were: for isoprene, rate $\propto$ dose $rate^{0.53}$; G $\propto$ dose $rate^{-0.48}$; for 2,3-dimethylbutadiene, rate $\propto$ dose $rate^{0.58}$; and G $\propto$ dose $rate^{-0.42}$. In the cases of both isoprene and 2,3-dimethylbutadiene, the reactions were zero order in the diene over the entire range of mole ratios investigated. (auth)

30598 RADIOLYSIS OF DIETHYL THALLIUM SULFATE IN AIR-SATURATED AQUEOUS SOLUTION. D. Sarrach (Deutsche Akademie der Wissenschaften, Berlin). Kernenergie, 6: 228-31(May 1963). (In German)

Aqueous air-saturated solutions of diethyl thallium sulfate were irradiated with Co^{60} gamma radiation. The chief radiolytic products were thallium(I) sulfate, hydrogen peroxide, acetaldehyde, and ethanol. In neutral 0.02N solutions the yields amounted to: $G(Tl^+)$ = 5.43 ± 0.27; $G(CH_3CHO)$ = 4.88 ± 0.24; $G(C_2H_5OH)$ = 6.4 ± 1.5; and $G(H_2O_2)$ = 2.90 ± 0.15. Diethyl thallium ions were shown to be good scavengers for the primary radicals of water radiolysis. In acid solutions the yields were diminished, probably by capture of the polarons by H_3O^+ ions. (tr-auth)

30599 INFLUENCE OF CRYSTAL DEFECTS ON THE ANNEALING OF CHEMICAL RADIATION DAMAGE. S. R. Mohanty and S. R. Upadhyay (Banaras Hindu Univ., Varanasi, India). Nature, 199: 169(July 13, 1963).

The influence of crystal defects on the annealing of radioinduced chemical damage was demonstrated in lead nitrate. (C.H.)

30600 CONTRIBUTION TO THE THEORY OF THE RADIATION POLYMERIZATION OF CLATHRATE INCLUSION COMPOUNDS. A. Ya. Temkin (Inst. for Petrochemical Synthesis, Academy of Sciences, USSR). Neftekhimiya, 2: 324-31(1962).

The kinetics of radioinduced polymerization of inclusion compounds were analyzed theoretically. The dependence of the average molecular weight of the polymer on the duration of irradiation was calculated for two cases: when the growth of the polymer chain proceeds from the points of initiation in both directions along the channel, and when growth of the chain takes place in one direction only.

Comparison with previously reported experimental results indicates that the growth of polymer chains from the point of initiation proceeds in one direction only, and that the observed decrease of average molecular weight of the polymer with duration of irradiation must be due to the fact that long channels, essential for growth of long polymer chains, become more and more scarce as polymerization proceeds. In order to decide with greater certainty how polymerization proceeds, a small known amount of foreign molecules that stop chain growth but are otherwise inactive should be allowed during polymerization. Then the final average molecular weight of the polymer will depend on the concentration of the inactive molecules in different ways, according to whether polymerization proceeds in both directions or in one only. (OTS)

30601 THE THEORY OF PHOTOIONIZATION OF F′ CENTERS. A. G. Cheban. Opt. Spectry. (USSR) (English Transl.), 14: 269-72(Apr. 1963).

A study is made of the ionization of F′ centers in ionic crystals. An expresssion is obtained for the probability of a multiphonon photoionization of an F′ center in two cases of absorption, namely with the formation of a polaron and a conduction band electron. The polaron absorption curve is obtained for a NaCl crystal; absorption curves are obtained for the formation of a conduction band electron for NaCl, KCl, and KBr crystals. A comparison of theoretical absorption bands and their half-widths with the experimental curves indicates that the experimentally observed F′ band is connected with the transition of an electron into the conduction band. (auth)

30602 NEW DATA ON THE THERMAL AND OPTICAL STABILITY OF M-CENTERS. I. A. Parfianovich, E. I. Shuralyeva, and V. G. Krongauz. Opt. Spectry. (USSR) (English Transl.), 14: 273-4(Apr. 1963).

Evidence indicating that the first peak of the thermal glow curve of NaCl arises not from M centers but from centers with less thermal stability is presented. Heating NaCl crystals to 100°C or exposing them to light (λ = 730 mμ) destroyed the first thermal peak, but only slightly diminished the M absorption band. The optical stimulation spectrum obtained by optical (400-800 mμ) deexcitation of x-ray excited NaCl–Ni and NaCl–Tl phosphors showed only an F absorption band at room temperature; at 100-120°C the M band appeared. (D.C.W.)

30603 ION PAIR ABSORPTION IN $PrCl_3$. G. H. Dieke and E. Dorman (Johns Hopkins Univ., Baltimore). Phys. Rev. Letters, 10: 17-18(July 1, 1963).

One photon was known to be able to excite two Pr^{3+} ions to different levels, one of which was always $^3P_0$ as detected by fluorescence. Using crystals of pure $PrCl_3$, 90 absorption lines corresponding to ion pair absorption were detected in the region between 22, 220, and 28,100 cm^{-1}. Classifications and wave numbers of the lines are given. The lines show no polarization, and most of their frequencies can be written as the sum of two ordinary absorption frequencies. The width of the lines is about 6 cm^{-1}. (D.C.W.)

30604 ON SORPTION OF STRONTIUM-90 BY ACTIVE MANGANESE DIOXIDE. Yu. V. Egorov and E. I. Krylov. Radiokhimiya, 5: 211-15(1963). (In Russian)

Radiochemical problems of Sr^{90} sorption by active manganese dioxide were analyzed. Equations were developed describing microquantities of Sr^{90} between the variable mass of active manganese dioxide sediment and solution for the cases for a free manganese dioxide coagulation (self-determined magnitude pH) in potassium chloride solution with a constant ion force and for a free coagulation in a variable ion force solution in constant molar ratio of coagulant to sorbent. It is also shown that the peculiarities of distribution equations from the point of view of acting masses are the result of a sorbent's chemical heterogeneity and its bonding of hydroxide ions formed in potassium permanganate reduction. (R.V.J.)

30605 COMPLEX FORMATION OF PROTACTINIUM IN NITRIC ACID SOLUTIONS. I. E. Starik and L. I. Il'menkova. Radiokhimiya, 5: 236-44(1963). (In Russian)

Solvent extraction of Pa from nitric acid solutions by tri-n-butyl phosphate was studied and composition of Pa complexes was determined. The mechanism of Pa extraction from 6 N HNO_3 by 25% TBP in benzene is described by the formula: $Pa(NO_3)_5 + 2\ TBP \rightleftharpoons [Pa(NO_3)_5 \cdot 2\ TBP]_{org}$, with the degree of $Pa(NO_3)_5$ solvation by TBP equal to 2 and equilibrium constant equal to 5.97. In nitric acid solutions with 6 N H^+ ions Pa forms neutral complexes $Pa(NO_3)_5$ at NO_3^- 1 to 3 N, with the NO_3^- increase from 3 to 6 N Pa forms negatively charged complexes $Pa(NO_3)^-$ and $Pa(NO_3)_7^{2-}$. The $Pa(NO_3)_5$ distribution constant equals 5(μ = 6: TBP = 25%). The step-by-step formation constant for $[Pa(NO_3)_6]^- - K_6$ was 0.141 and for $[Pa(NO_3)_7]^{2-} K_7$ it was 1.09, at ion force 6. The general formation constant β_6 was about equal to β_7. (R.V.J.)

30606 RADIOLYSIS OF FROZEN AQUEOUS SOLUTIONS. V. A. Sharpatyi (Karpov Inst. of Physics and Chemistry, USSR). Usp. Khim., 32: 737-53(June 1963). (In Russian)

Electron paramagnetic resonance and luminescence analysis were made of the kinetics of finite product accumulations in radiolysis of ice and frozen aqueous solutions. Radiolytic effects in solid aqueous solutions and intermediate radical products of radiolysis were also analyzed. (R.V.J.)

30607 EFFECTS OF Co^{60} γ RAYS ON OXIDIZED COAL ION EXCHANGE PROPERTIES. I. A. Kuzin, A. M. Semushin, and V. P. Taushkanov. Zh. Prikl. Khim., 36: 914-17(Apr. 1963). (In Russian)

Studies were made of γ-radiation effects on anion and cation exchange properties of various oxidized coals. Oxidation of activated coals by nitric acid produced ion exchangers with cation capacity of 2.41 to 4.87 mg/equiv/g. It is shown that physico-chemical and ion exchange properties of oxidized coals are not affected by radiation doses from 1.5×10^8 to 1.9×10^8 r. (R.V.J.)

30608 CHEMICAL PATHWAYS FOR THE PREPARATION OF LABELED DERIVATIVES OF DIHYDROXYACETONE. Melvin Harold Weinswig. Thesis, Chicago, Univ. of Illinois, 1962. 53p.

The object of this investigation was to devise a chemical synthesis of dihydroxyacetone phosphate in a manner that could produce a product uniquely labeled at carbon atoms 1, 2, or 3. This compound would be useful for the enzymatic synthesis of D-fructose-1,6-diphosphate uniquely labeled with C^{14} in any position, a specificity of labeling that has never been before achieved in hexoses. The synthesis was accomplished by treating chloroacetamide with sodium benzoate to prepare benzoylglycolamide. The amide was converted into the corresponding carboxylic acid and thence into acid chloride. The acid chloride was transformed into the diazoketone which upon reaction with ortho-phosphoric acid afforded 1-benzoxy-3-hydroxypropanone. This intermediate was ketalated with trimethyl orthoformate in methanolic hydrogen chloride and the alcohol group phosphorylated with di-

phenyl phosphorochloridate. The phenyl groups were removed by hydrogenolysis and the ester hydrolyzed with barium hydroxide. The dimethyl ketal of dihydroxyacetone phosphate was then isolated as its cyclohexyl ammonium salt. Starting with chloroacetamide, the dimethyl ketal of dihydroxyacetone phosphate was obtained in an overall yield of 26%. A similar synthesis was carried out from acetylglycolic acid and the dimethyl ketal of dihydroxyacetone phosphate was isolated in less than 0.1% overall yield. Attempts were made to use the key intermediate, 3-benzoxy-1-diazopropanone, to provide a shorter route to dihydroxyacetone phosphate. These attempts were unsuccessful. (Dissertation Abstr., XXIII, No. 12(I))

30609 GAMMA RADIATION INITIATED POLYMERIZATION OF FLUOROMONOMERS. I. HOMOPOLYMERS. P. J. Manno (Continental Oil Co., Ponca City, Okla.). 11p. (CONF-14-11)

From American Chemical Society, 144th National Meeting, Los Angeles, Mar.-Apr. 1963.

Fluoromonomers in a reactor cooled in a liquid N bath and degassed were exposed to gamma doses of 1 to 5×10^6 reps from Co^{60} and spent fuel elements. The recovered polymers were cycle-dried and pulverized. G-values percent polymerization, moldability, and melting range were evaluated. Vinyl fluoride polymerization received particular attention. The presence of solid polyethylene accelerated the polymerization, and G values of 15,000 and 6400 were calculated at 0.7 and 5×10^5 reps/hr. The effect of temperature on vinyl fluoride polymerization and the physical properties of the polyvinyl fluoride were also examined. (D.C.W.)

30610 RADIATION INDUCED CHLORINATION OF BENZENE. Richard Earl Faw. Thesis, Minneapolis, Univ. of Minnesota, 1962. 166p.

The radioinduced reaction between benzene and Cl_2 in the liquid phase has been studied using a continuous stirred tank reactor system. Radiation sources used were 1000 C of Co^{60} and 10,000 C of Cs^{137} located in the Gamma Irradiation Facility of the Univ. of Minnesota. The concentrations of Cl were very low (0.025 to 0.5 M), and the reaction was studied at very high exposure dose rates (65 to 320 kiloroentgens/hr). Reaction rates were determined from differences in Cl concentrations of the inlet and outlet streams of the reactor. Chlorine concentrations were continuously monitored with a flow colorimeter. Intermittent samples of the streams were analyzed for free Cl using an iodimetric method. Infrared spectra and combined Cl analyses were performed on representative samples of the chlorination product. Radiation dose rates were determined using ferrous sulfate dosimetry. In agreement with previous studies of both the ultraviolet and the γ-induced reactions, the reaction was found to be a chain reaction, first order with respect to Cl concentration, resulting in the formation of a mixture of the stereoisomers of 1,2,3,4,5,6-hexachlorocyclohexane. No effect of temperature on reaction rate was observed in the range 15° to 30°C. No effect of reactor surface to volume ratio was observed. At constant radiation intensity, the reaction rate was found to decrease with increasing residence time (hold-up time) in the reactor. This effect was attributed to the buildup of an inhibitor during the course of the reaction. Decomposition products resulting from the radiolysis of benzene were considered very likely to act as inhibitors either through chlorine atom scavenging or through quenching of electronically excited benzene. The mechanism of the reaction was considered in view of the experimentally determined over-all rate expressions. The following suggestions were made: The chain reaction may be initiated by Cl atoms resulting from the dissociation of molecular Cl. The dissociation may occur as a result of direct interaction with high energy radiation or as a result of energy transfer from electronically excited benzene. Chain propagation may result from reactions of two types, e.g., reaction between a Cl atom and a benzene molecule to form a chlorocyclohexadienyl free radical and subsequent reaction of the dienyl free radical with molecular Cl to form dichlorocyclohexadiene and another Cl atom. Chain termination may occur either by Cl atom recombination or by reactions such as that between a dienyl free radical and a Cl atom. (auth)

30611 IMPROVEMENTS IN POLYETHYLENE COMPOSITIONS AND THEIR PRODUCTION. (to W. R. Grace and Co.). British Patent 927,519. May 29, 1963. Priority date Aug. 2, 1960, United States.

High-density polyethylene compositions of improved clarity, dyeability, and forming properties can be produced by blending a parent polymer consisting of non-crosslinked polyethylene with 0.01 to 20% (by weight of parent polymer) of an additive consisting of crosslinked polyethylene with a vinylidene compound grafted onto it. Low-dose irradiation is sufficient to produce grafting. (D.C.W.)

30612 ENCAPSULATION OF PARTICLES BY LIQUID-LIQUID PHASE SEPARATION. (to Upjohn Co.). British Patent 930,421. July 3, 1963. Priority date Dec. 22, 1958, United States.

The hardness and impermeability of polymeric membranes containing particles (oils, medicine, etc.) can be improved by forming the membranes around the particles by a liquid-liquid phase separation process, setting the membranes, and irradiating them with beta, gamma, or x-rays. (D.C.W.)

Raw Materials and Feed Materials

30613 ON THE PHASE CHANGES IN U_4O_9 REDUCTION. V. M. Zhukovskii, E. V. Tkachenko, and V. G. Vlasov (Kirov Ural Polytechnic Inst., USSR). Fiz. Metal. i Metalloved., 15: 210-14(Feb. 1963). (In Russian)

An analysis was made of various opinions on the state and structure of phase components in uranium–oxygen systems of $UO_2-UO_{2.25}$. Reduction of U_4O_9 by decomposed ammonia and solid carbon was analyzed, and the dependence of uranium dioxide lattice parameter on the amount of diffused oxygen was determined. The $UO_2-UO_{2.25}$ structure was developed. (R.V.J.)

30614 PHASE TRANSFORMATIONS IN URANIUM OXIDE REDUCTION BY SOLID CARBON. E. V. Tkachenko and V. G. Vlasov (Kirov Ural Polytechnic Inst., USSR). Fiz. Metal. i Metalloved., 15: 239-43(Feb. 1963). (In Russian)

Kinetic and x-ray studies were made of UO_3, mixed oxides, and β UO_2 reduction by solid carbon (acetylene black) at 400 to 500°, 650 to 800°, and 700 to 950°C, respectively. The phase transformation for UO_3 was $UO_{3\ amorph.} \rightarrow UO_{2.91} \rightarrow U_3O_8 \rightarrow U_3O_{8-z\ max}$; for mixed oxide, $U_3O_8 \rightarrow U_3O_{8-z_{max}} \rightarrow U_4O_9 \rightarrow UO_{2+x_{max}} \rightarrow UO_{2+x}$; and for β uranium dioxide, $U_4O_9 \rightarrow UO_{2+x_{max}} \rightarrow UO_{2+x}$. (R.V.J.)

30615 VALVES FOR THE HIGH PRESSURE-HIGH TEMPERATURE (HP-HT) FLUORINATION SYSTEM. (Engineering Materials). (Union Carbide Nuclear Co., Paducah, Ky.). (CAPE-998)

This package contains two drawings of valves which

eliminate errors in the gravimetric oxide dilution procedure of U^{235} measurement. Isotopic contamination in the high pressure fluorination reactor was corrected by changing the manner in which the Cu tubing joins the valve and by modification of the bellows. The compact inlet system was modified to improve the precision of the spectrometer analyses. Changes were made in the basic leak and the air operator, which is a diaphragm-type valve, so that the setting of the flow level is controlled by the closure spring adjustment screw. This capillary-type leak has increased control range and smooth control characteristics. It is simple to construct, is remotely operated and is free from corrosion failure. (F.S.)

Separation Processes

Refer also to abstracts 29961 and 31081.

30616 (CONF-14-15) FLUORESCENT ION EXCHANGE RESINS. Alvin H. Heimbuch, Harry Gee, and Howard Bould (Tracerlab. Div. of Lab. for Electronics, Inc., Richmond, Calif.). [1962]. Contract [AT(04-3)-453]. 22p.

From the American Chemical Society Meeting, Los Angeles, March–April, 1963.

The development of scintillating ion exchange resins is discussed. A suspension-type polymerization process was developed whereby a fluorescent, spherical bead was made which contained the appropriate fluors dissolved in solid solution in cross-linked polyvinyltoluene. The plastic bead was subsequently treated chemically to introduce the anion, or cation, exchange groups. The relative pulse height of each resin preparation was measured to determine the effects of various synthesis parameters and to make comparisons between batches. Counting efficiencies for α and β emitters were determined. An experiment was performed to determine the efficiency with which the scintillating anion resin could remove I^{131} from milk. The stability of the resin was also studied. (M.C.G.)

30617 (NYO-6550) EXTRACTION OF INORGANIC SUBSTANCES BY ORGANIC SOLVENTS. Progress Report, November 1, 1953–July 1, 1954. D. E. Byrnes, A. J. Hogan, and H. M. Clark (Rensselaer Polytechnic Inst., Troy, N. Y. Walker Lab.). July 15, 1954. Contract AT (30-1)-1663. 6p.

The separation of aluminum chlorides from aqueous ether solutions by precipitation using water and moist ether solutions is evaluated. The preparation of aluminum chloride with ether at dry ice temperatures is described. The reaction of diethyl ether with aluminum chloride is discussed. Techniques for the purification of hydrobromic acid are evaluated. (N.W.R.)

30618 (NYO-6551) EXTRACTION OF INORGANIC SUBSTANCES BY ORGANIC SOLVENTS. Progress Report, November 1, 1954–July 1, 1955. H. M. Clark (Rensselaer Polytechnic Inst., Troy, N. Y. Walker Lab.). July 15, 1955. Contract AT(30-1)-1663. 11p.

The effects of addition of water and hydrogen chloride to anhydrous solutions of aluminum chloride in diethyl ether are compared with ferric chloride-ether system. Results of light absorption and conductance measurements are given. The preparation of ferric bromide and separation of ferric bromide from aqueous solutions by solvent extraction using diethyl ether are discussed. (N.W.R.)

30619 (NYO-6552) EXTRACTION OF INORGANIC SUBSTANCES BY ORGANIC SOLVENTS. Progress Report, July 1, 1955–July 1, 1956. H. M. Clark (Rensselaer Polytechnic Inst., Troy, N. Y. Walker Lab.). July 15, 1955. Contract AT(30-1)-1663. 12p.

The preparation of the acid $HAlCl_4$ by dissolution of pure aluminum metal chips by anhydrous chloride in dry diethyl ether in an all-glass apparatus and by converting a known tetrachloroaluminate salt such as $LiAlCl_4$ and $NaAlCl_4$ to the acid is discussed. Evaluation of tantalum-182 as a tracer in the solvent extraction of tantalum chloride from aqueous solutions using organic solvents is made. The separation of ruthenium chloride from hydrochloric acid solutions by solvent extraction using TBP is reported. The solvent extraction of ferric bromide from aqueous solutions using diethyl ether is discussed. Methods for the analysis of the aqueous and organic phases are described. The visible absorption spectra of the system are evaluated. The distribution of hydrogen bromide between water and diethyl ether is given. (N.W.R.)

30620 (NYO-6553) EXTRACTION OF INORGANIC SUBSTANCES BY ORGANIC SOLVENTS. Progress Report, July 1, 1956–June 1, 1957. Herbert M. Clark (Rensselaer Polytechnic Inst., Troy, N. Y. Walker Lab.). June 1, 1957. Contract AT(30-1)-1663. 12p.

The anhydrous acid $HAlCl_4$ is prepared by slow addition of metallic aluminum chips to cold diethyl ether saturated with anhydrous hydrogen chloride in a glass apparatus. The separation of ruthenium chloride from hydrochloric acid solutions by solvent extraction using TBP is reported. The solvent extraction of tantalum chloride from hydrochloric acid solutions into tri-n-butyl phosphate is studied where small additions of hydrofluoric acid are made to the solutions. The solvent extraction of ferric bromide from aqueous solutions by diethyl ether is discussed with respect to distribution ratios. (N.W.R.)

30621 (NYO-6555) EXTRACTION OF INORGANIC SUBSTANCES BY ORGANIC SOLVENTS. Progress Report, June 1, 1957–May 31, 1958. Herbert M. Clark (Rensselaer Polytechnic Inst., Troy, N. Y.). June 2, 1958. Contract AT(30-1)-1663. 22p.

The tetrachloroaluminate complex, $AlCl_4^-$, is prepared and identified by Raman spectroscopy. The separation of aluminum chlorides from diethyl ether solutions by solvent extraction is discussed. The paramagnetic resonance behavior of tetrachloroferrate ion in isopropyl ether is discussed. The solvent extraction of tantalum chloride from hydrochloric acid solutions into tri-n-butyl phosphate is studied where small additions of hydrofluoric acid are made to the solutions. For this separation, work is reported in three general areas: aging effects on the distribution ratio; ultraviolet spectrophotometric investigations of aqueous and organic phases; and extraction studies designed to lend information about the nature of the extracting species. The solvent extraction of ferric bromide from aqueous bromide solutions into diethyl ether is discussed. The effect of a change in temperature and in iron concentration on the extraction coefficient is studied. (N.W.R.)

30622 FIXATION OF NUCLEAR FISSION PRODUCTS ON HUMIC ACIDS AND POSSIBLE APPLICATIONS OF THE PHENOMENON IN NUCLEAR ENGINEERING. Sándor Szalay. Magy. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 5: 3-16(May 1963). (In Hungarian)

It was ascertained that a peat preparation concentrated in humic acids and obtained from muskeg through purification will extract cations from aqueous solutions containing metal ions, thus resulting in an enrichment of cations in the humus. The numerical expression of the concentration process gives a Langmuir's adsorption isotherm, in the knowledge of which one can determine the enrichment

factor ($N_m \cdot a$) of the humic preparation with respect to the various cations. In the cases of some cations, this value is in the order of 10^4. This was followed by laboratory experiments in which it was ascertained that many of the fission products are also well fixed by humic preparations. The significance of the binding phenomenon is especially great for the nuclear engineering to handle reactor effluents in view of the fact that peat yields a concentrating substance at the lowest price. It is easy to solve the problem of post-handling and storing peat preparations saturated with fission products. (auth)

30623 ELUTION OF THORIUM FROM STRONG ANIONS. E. I. Kazantsev and V. A. Kudusov. Radiokhimiya, 5: 231-6(1963). (In Russian)

Elution of thorium from strong anionites AM-10 and AB-17 by water and ammonium solutions of perchloric, hydrochloric, nitric, and sulfuric acids was studied. The efficiency of thorium elution from 7 N HNO_3 by AB-17 and AM-10 by the above reagent was found to be: H_2SO_4 > HCl > HNO_3 > $(NH_4)_2SO_4$ > NH_4NO_3 > H_2O > $NClO_4$. Solutions of 0.1 N nitric, hydrochloric and sulfuric and 2 N solutions of hydrochloric and sulfuric acids are recommended for Th elution from the anions. (R.V.J.)

30624 THE SOLVENT EXTRACTION OF FISSION PRODUCTS. R. Thacker. Thesis, Mainz, Universität, 1961. 214p. $2.00.

The extraction of some typical fission products from HCl solutions with triisooctylamine is studied. Extraction curves for various HCl, carrier, and amine concentrations are given. The extraction method can be used for very high carrier concentrations. Extracted quantities are independent of carrier concentration up to 1 mg/ml. (Gmelin Inst.)

30625 SEPARATION OF TRANSURANIUM ELEMENTS BY SOLVENT EXTRACTION WITH ALKYLPHOSPHORIC ACIDS. V. N. Kosyakov (International Atomic Energy Agency, Vienna), E. S. Gureev, and G. N. Yakovlev. 26p. (CONF-72-2).

From Transplutonium Element Symposium, Argonne, Ill., May 1963.

Mono- and dialkylphosphoric acids were studied as extractants for transuranium elements of different valency (III, IV, V, VI). It was found that the mechanism of extraction of Me^{3+}, Me^{4+}, and MeO_2^{2+} has a cation exchange nature and that the distribution coefficients of these cations are affected differently by hydrogen ion concentration, complexing anion concentration in aqueous phase, extractant concentration, and diluent nature. This characteristic together with oxidation-reduction reactions makes possible many techniques for the separation of the transuranium elements from each other. Several examples of separation techniques are described. The different ability of the trivalent actinide and lanthanide elements for complex formation with SCN^- anions was used for developing an extraction method of separation of americium from the lanthanide fission products. (auth)

30626 THE SEPARATION OF LARGER QUANTITIES OF RARE EARTHS WITH ION EXCHANGE AND EXTRACTION METHODS. H. Richter. Thesis, Leipzig, Universität, 1961. 162p. $2.00.

The separation of various pure rare earths from monazite and gadolinite was investigated. Separation procedures using ion exchange techniques are described in detail. (Gmelin Inst.)

30627 EXTRACTION OF URANIUM BY MEANS OF ANION EXCHANGE FROM SULPHATE SOLUTIONS AFTER LEACHING. T. V. Arden. p.146-79 of "Izvdechenie i Ochistka Redk. Metallov." Moscow, Atomizdat, 1960.

A flow sheet for the extraction of U and other elements from their sulfate liquors after leaching U-containing ores by means of ion exchange resins is described. Properties of uranyl anionic sulfate complexes and the influence of pH on their stability were studied. Results of washing out U from the resins by means of HNO_3 solution of NH_4NO_3 in a 3-column plant are given. Difficulties that occurred during the factory exploitation of the anion exchange plant are noted. (Referativnyy zhurnal, Khimiya, No. 11, 1962)

30628 EQUIPMENT USED IN COLD RECOVERY OF ENRICHED URANIUM. (Engineering Materials). (Union Carbide Nuclear Co., Oak Ridge, Tenn.). (CAPE-992)

This package contains 6 drawings of equipment used in the cold recovery process of enriched uranium. Pulse columns, pulse generators, a 5-in. denitrator, and an evaporator are included. A pulse generator is used for each of the 6-in. OD and the 4-in. OD pulse exchange columns. These columns are in five sections: 2, 10.75, 10.75, 3.75, and 2.5 ft. The first three (lower) sections are made of type 304 stainless steel pipe, 0.125-in. thick, and the last two (upper) sections are made of pyrex No. 7740 glass. The denitrator is made of type 304 stainless steel fabricated in the shape of a trough with inside measurements 18-in. long, 5-in. wide, and 6.7-in. deep. The bottom of the trough is in the shape of a half cylinder with a 2.5 in. radius. The denitrator has four 5-in. paddles and four 3.5 in. paddles. The evaporator consists of a calandria in two sections, each 7 ft long joined by an expansion joint, with a steam nozzle at one end and a condensate nozzle at the other end. Other evaporator equipment includes a cyclone and two entrainment separators. (R.E.C.D.)

30629 THE EXTRACTION OF NIOBIUM AND TITANIUM FROM SULPHURIC ACID SOLUTIONS. N. M. Sobinyakova and M. A. Soynova. p.132-47 of "Razdelenie Blizkikh po Svoystvam Redkikh Metallov. Mezhvuz. Konfer. po Metodam Razdel. Blizkikh po Svoyst. Red. Metallov." Moscow, Metallurgizdat, 1962.

Experiments were carried out with synthetic and technological leaching of solutions, in order to study the possibility of extraction of Nb and Ti with ion exchange substances and liquid extraction agents from sulfuric acid solutions, obtained from concentrates insufficiently enriched in Nb (containing 5 to 10% of Nb_2O_5). The optimum acidity for adsorption was investigated in pure solutions. In the range 6 to 7 M, H_2SO_4 sorption of Nb and Ti is approximately the same (if their concentrations in the solution are equal) and this range is advantageous for combined extraction of these two metals, so that the solutions impoverished in Nb and Ti can be re-used for decomposing fresh concentrates. The influence of Nb and Ti on each other when present simultaneously in the solutions in variable quantities was determined at acidities 3, 4, and 6 M H_2SO_4. In the separation of Nb and Ti from technological solutions, the metals were elutriated with 10% HCl after a preliminary wash with 2.5% H_2SO_4, which removed the adsorbed Fe. Nb was extracted with the first portions of the elutriant; concentrates with up to 94% NB_2O_5 and 96 to 99% TiO_2 were obtained. From the H_2SO_4 solutions Nb was extracted with an alkyl phosphate extracting agent, dibutyl pyrophosphate, bis(2-ethylhexyl) phosphate, and trioctylamine. All reagents extracted both Nb and Ti. (TCO)

30630 REMOVAL OF CESIUM FROM AQUEOUS SOLUTIONS BY ADSORPTION. Kenneth C. Knoll (to U. S.

Atomic Energy Commission). U. S. Patent 3,097,920. July 16, 1963.

A process of removing microquantities of cesium from aqueous solutions also containing macroquantities of other ions by adsorption on clinoptilolite is described. The invention resides in the pretreatment of the clinoptilolite by heating at 400°C and cooling prior to use. (AEC)

30631 FLUORINATION OF OXIDIC NUCLEAR FUEL. William J. Mecham and John D. Gabor (to U. S. Atomic Energy Commission). U. S. Patent 3,098,709. July 23, 1963.

A process of volatilizing fissionable material away from fission products, present together in neutron-bombarded uranium oxide, by reaction with an oxygen–fluorine mixture at 350 to 500°C is described. (AEC)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstracts 29975, 29976, 29977, 29978, 29979, 29980, 29981, 30015, 30060, 30061, 30062, 30063, 30065, and 30149.

30632 (AD-408447) BLAST LOADING OF CONCRETE BEAMS REINFORCED WITH HIGH-STRENGTH DEFORMED BARS. Technical Report R-226. Type C. William A. Keenan (Naval Civil Engineering Lab., Port Hueneme, Calif.). Apr. 22, 1963. 99p.

Economical blast-resistant concrete structures can be constructed by reinforcing concrete members with high-strength deformed bars if such members can meet the requirements of adequate strength and ductility under blast loading and limited deflections and formation of cracks under static service loads. A theoretical study and a series of beam tests were made to determine if concrete members reinforced with high-strength deformed bars can meet the above requirements. In the theoretical study, the influence of the amount, yield strength, and ductility of the tensile steel and the amount, location, and yield strength of the compression steel on the strength and ductility of a concrete beam is discussed. Then, the influence of the amount and yield strength of tensile steel on the stiffness of a beam is presented. The minimum yield-load factor (ratio of the beam's static yield resistance to the static service load) required to limit deflections to any given amount is presented as an equation and is plotted for various span-to-depth ratios. In the tests, sixteen simply supported concrete beams reinforced with high-strength deformed bars (91,600 psi yield stress) were subjected to static and dynamic uniform loads and their behavior observed. Eight beams were conventionally reinforced, and eight were partially prestressed. The prime purpose of the prestressing was to limit the cracks and deflections. Both types of beams were subjected to long- and short-duration loads. Several beams were loaded dynamically more than once to determine their resilience and to study the problem of multiple-shot damage. The static and dynamic tests are reported, evaluated, and compared with theory. Equations for the static collapse deflection and the maximum dynamic deflection of a uniformly loaded concrete beam are presented. It was concluded that the two major factors which may restrict the use of high-strength steel in blast-resistant design are the inability of such a steel to elongate a required minimum amount and excessive deflections and/or cracks of beams reinforced with high-strength steels under static service loads. The tests demonstrated that more resistance can be gained with a lesser amount of high-strength steel than lower grades of steel and that chromium-alloy steel of the type used in this investigation has a sufficient amount of ductility for use in simply supported beams. Both the theoretical study and the experimental tests indicate that excessive deflections may be controlled by prestressing the tensile steel. (auth)

30633 (ASD-TR-7-886(II)) DEVELOPMENT OF 2400°F FORGING DIE SYSTEM. Interim Technical Progress Report No. 9, March 28, 1963–June 27, 1963. P. R. Gouwens, H. Nudelman, and T. Watmough (Illinois Inst. of Tech., Chicago. IIT Research Inst.). July 1963. Contract AF33(600)-42861. 17p.

The basic die assembly previously constructed for prototype work is satisfactory for supporting the actual working dies and their retainer rings. The material selections were made for these parts and will utilize a self-bonded SiC as the upper male die, an 85% W–15% Mo cast lower die, and a 97% W–15% Mo retainer ring assembly for both dies. The attainment of 2400°F at the male die insert and 2300°F at the bottom die cavity was demonstrated using a combination of electrical resistance heating in the die base and flame heating of the die impressions. Protection of the metallic dies at these temperatures is by means of a CaF–NaF salt mixture. (auth)

30634 (NP-12961) FUNDAMENTALS OF PROTECTIVE DESIGN. Engineer Manual for War Department Construction. (Corps of Engineers). 1946. 190p.

This manual was prepared as a guide for engineers in the planning and design of protective structures, fortifications, gun batteries, and components of military installations. The fundamental phenomena of various military weapons and their structural effects are discussed and examples in application of the data to specific design problems are given. Sufficient information is included to determine the requirements and design procedure for protection against explosives, fire attack, and war gases. (C.H.)

30635 (TID-19092) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. (1) CYCLIC PRESSURE TESTS OF LARGE SIZE PRESSURE VESSELS. (2) EFFECTS OF NOTCHES AND WELD DEFECTS ON PRESSURE VESSEL FATIGUE STRENGTH. Progress Report No. 3, April 1, 1963–June 21, 1963. A. G. Pickett and W. R. Schmidt (Southwest Research Inst., San Antonio). June 28, 1963. Contract AT(11-1)-1228. 23p.

The plastic fatigue strength of large pressure vessels is investigated with respect to materials, design details, fabrication methods, and inspection techniques. Stress concentration factors determined in the static stress analysis, effects of strain redistribution upon initial cycling, and results of plastic fatigue tests are correlated. (N.W.R.)

30636 (FTD-TT-63-496) A PUMP FOR PUMPING LIQUID (MOLTEN) METAL. Yu. M. Chepele. Translation of Russian Patent No. 143982. 5p.

An electromagnetic pump for molten metals is described in which the liquid moves in the annular space between two concentrically situated pipes. The inner pipe is movable, is magneto-conductive, and is fitted with magneto-conductive coils and washers. The metal is fed sideways in the pump and is transported under the effects of the running magnetic field. (J.R.D.)

30637 EXPERIMENTAL PLASMAJET THRUSTOR RESULTS. Paul S. Masser. AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 1651-2(July 1963).

Experimental and analytical development work on thermal arc jet propulsion devices for operation in the general area of 800 to 1200-sec specific impulse is described. The major accomplishment is the development of the hot-wall thrustor design to the point where theoretical frozen flow efficiencies were equaled or slightly exceeded during several tests. Repeated experimental measurements of 50% efficiency at 1000 sec were made. Heat transfer and efficiency are analyzed, and extensive experimental data are discussed. (auth)

30638 CRYOSTAT FOR INVESTIGATIONS TO TEMPERATURES BELOW 0.02°K. E. D. Adams and J. M. Goodkind (Stanford Univ., Calif.). Cryogenics, 3: 83-5 (June 1963).

A cryostat was constructed for studies of the properties of He^3. The cooling stages of the cryostat are a He^3 refrigerator, a 300-g salt pill of potassium chrome alum, and a 150-g pill of cerium magnesium nitrate. Superconducting heat switches and magnets are used. The temperature is measured using nuclear magnetic resonance. The lowest temperature obtainable was about 0.014 or 0.015°K. (D.L.C.)

30639 A FLEXIBLE AND TRANSPARENT TRANSFER TUBE FOR LIQUID HELIUM. R. A. Kimber (Rutherford Lab., Harwell, Berks, Eng.). Cryogenics, 3: 104(June 1963).

A transparent, double-walled transfer tube was designed for transferring liquid helium between a cryostat and a storage Dewar. The tube comprises inner and outer jackets of PVC tubing spaced apart by expanded polystyrene. The jackets are pushed over brass connectors and inner tubes immersed in the containers. (D.L.C.)

30640 CRYOGENIC LEVEL DETECTOR AND LEVEL CONTROL CIRCUIT. F. B. Otto and O. R. Gilliam (Univ. of Connecticut, Storrs). Cryogenics, 3: 111(June 1963).

A circuit was devised for determining the liquid level in a sealed helium reservoir. The circuit comprises a neon lamp in parallel with a carbon resistor; the lamp lights only when the resistor is in the liquid helium. A similar circuit was devised as a liquid nitrogen level controller. (D.L.C.)

30641 A 100,000 GAUSS SUPERCONDUCTING SOLENOID. D. L. Martin, M. G. Benz, C. A. Bruch, and C. H. Rosner (General Electric Research Lab., Schenectady, N. Y.). Cryogenics, 3: 114(June 1963).

A superconducting coil was constructed which created a field of 101,000 gauss and a current of 266 amp at 1.8°K. The coil was wound from 600 ft of a 0.027-in. dia tin-clad niobium conductor and heated for 4 hr at 950°C. (D.L.C.)

30642 SOLAR CELLS. J. Evans (Standard Telecommunication Labs. Ltd., Harlow, Essex, Eng.). J. Brit. Interplanet. Soc., 19: 62-8(May-June 1963).

The basic principles of conversion of sunlight into electrical energy in a semiconductor p-n junction are described. From the theory, prediction of the expected performance as a function of external and internal parameters is made, and the maximum efficiency for a number of likely semiconductors quoted. Practical results are given for typical arrangements, including space projects already successful and proposed for the future. The effects of the space environment on performance and life are discussed. Finally, the direction and promise of future developments are indicated. (auth)

30643 DESIGN STUDY OF A 3 KW_e. INFLATABLE SOLAR TURBOELECTRIC GENERATOR. P. A. E. Stewart. J. Brit. Interplanet. Soc., 19: 69-80(May-June 1963).

The components of the communications system for satellites are examined in detail and design calculations presented. The initial power rating is 3 kW_e. An analysis of power cycles, working fluid, and operating temperatures is given, followed by discussions of the foam-rigidized concentrator, double cavity absorber, lithium hydride thermal storage subsystem, radiator and condenser, and attitude control system. (auth)

30644 SMALL NON-CONVENTIONAL ELECTRICAL POWER SOURCES. G. W. Wilson (C. A. Parsons and Co., Ltd., Newcastle upon Tyne, Eng.). J. Brit. Interplanet. Soc., 19: 81-6(May-June 1963).

The present status of each of three methods of conversion of heat or light into electrical power without the use of rotating machinery is surveyed: thermoelectricity, thermionic conversion, and photovoltaic converters. A comparison of practical devices indicates that for some time each method will find specialized applications. (auth)

30645 SOLID STATE LABORATORY, BUILDING 3025 (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-989)

This package contains 155 drawings. The laboratory is contained in a two-story steel-framed reinforced-concrete structure 58 × 106 ft. Partitions and doors are made of hollow metal. The purpose of the hot cells in this laboratory is for the physical and metallurgical examination of high-level radioactive materials. On the first floor are laboratories, offices, working areas, and cells. There are laboratories and offices on the ground floor. There are two mezzanines and a penthouse. The penthouse houses the toxic laboratory. Cell 1 is the machine shop. Cell 2 is used for remote metallography. Cells 3 and 6 are general purpose cells. Cell 4 is used as a corrosion examination cell. Cell 5 is a divided cell used for tensile testing. A metallographic cell is located adjacent to the north wall of Cell 2. (F.S.)

30646 METALLOGRAPHIC EQUIPMENT USED IN HRLEL (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-921)

This package contains 21 drawings. The High Radiation Level Examination Laboratory (HRLEL) employs only remote control equipment. A cut-off machine, used successfully in high radiation, and a vibratory polisher specimen holder, used with the Syntron Polisher, are two items of metallurgical equipment that are described. The vibratory polisher is a modified Syntron Polisher that is used in metallography. The modifications consist of the addition of 24-hour timers and a new specimen holder which eliminates small crevices, and is self-aligning. Ultrasonic cleaning is facilitated with the elimination of crevices. (F.S.)

30647 MODIFIED BALL AND SOCKET COUPLING (Engineering Materials). (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). 3 units. (CAPE-922)

This package contains three drawings of a modified ball and socket coupling used in hot cell manipulators. The male and female members may be engaged or disengaged without visual aid. Slots in an internal spherical seat of the female member are provided to accommodate appropriately arranged ribs in the male member. Accidental disengagement is prevented by rotation of the member which locks them together. (F.S.)

30648 HOT ANALYTICAL FACILITY. (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-28 REV)

This package contains 115 drawings, 114 pages of specifications, and 22 photographs of the High Radiation Level Analytical Facility (HRLAF), which is used to isolate and to centralize remotely controlled analytical operations into one area. The storage cell is centrally located with three work cells on one side and four on the other. A Cold Preparation Zone is in front of the cells for use in operating equipment to control work inside the cells. Cell No. 1 is used for non-routine work with equipment which is disassembled and removed when the work is finished. A small disposal unit and a densimeter are permanent in the cell.

Cell No. 2 contains a free-acid titration unit, pipettor, and a microelectric unit for measuring pH. Cell No. 3 is equipped with a Beckman, Model K, automatic titrator, a filter photometer, and a pipettor. Cell No. 4 contains a coulometric titration unit, three dropping mercury polarograph cells, a filter photometer, and a centrifuge. Cell No. 5 contains extraction, distillation, and colorimetric equipment. Cell No. 6 contains a Jaco-varisource spectrograph. Cell No. 7 is used in analytical work requiring heat and contains two hot plates and a fume hood. (F.S.)

30649 IMPROVEMENT IN OR RELATING TO AN APPARATUS FOR EXTRACTING INDIVIDUAL SPHERICAL OBJECTS FROM A LARGE STOCK THEREOF. (to W. C. Heraeus GmbH). British Patent 923,546. Apr. 10, 1963. Priority date July 26, 1958, Germany.

A device for removing spherical objects from the lower part of a large quantity without jamming is patented. The bottom of the container holding the spheres is inclined to the vertical and closed by a disk. The disk has an elongated radial slot, with a width slightly larger than the diameter of the spheres and a length larger than 3 times the diameter. When the disk is rotated or oscillated, the spheres are discharged through the slot. If the spheres are to be discharged singly, the disk should be thick enough so that the spheres are enclosed in the slot. As the disk rotates, it passes a slot in a screen, the slot being offset so that the spheres pass singly through the screen. The device is particularly applicable to removing spherical fuel elements from reactors. (M.P.G.)

30650 HEAT EXCHANGERS. (to Sulzer Freres, Societe Anonyme). British Patent 924,970. May 1, 1963. Priority date Jan. 29, 1960, Switzerland.

The design of a compact heat exchanger for particular use in small nuclear power plants, such as in ships, is patented. The heat is transferred from a gaseous to a liquid evaporable medium, but the design can be applied to other kinds of media. The heat exchanger consists of a vessel containing a number of chambers formed by nested partitions. One of the working media flows successively through the chambers, while the other medium flows through pipe lines in the chambers. The pipes in one chamber are connected in bunches for parallel flow and are helically wound to form concentric pipe "cylinders". The working medium flows through the chambers in such a way that only the coolest medium is in contact with the vessel wall. (M.P.G.)

30651 IMPROVEMENTS RELATING TO APPARATUS FOR PRODUCING VERY STRONG MAGNETIC FIELDS. Thomas Edward Allibone (to Associated Electrical Industries Ltd.). British Patent 925,508. May 8, 1963. Filed May 23, 1958.

An apparatus for producing high-intensity magnetic fields consists of an electrical solenoidal conductor winding of Al and a means for circulating very-low-temperature coolant along the conductor to maintain it at a low temperature. The Al was purified to produce a very high conductivity, and the conductor may be in the form of hollow tubing with the coolant circulated through it. The solenoidal winding may be used in electrical discharge apparatus and in thermonuclear equipment to provide a stabilizing field parallel to the gas discharge. (M.P.G.)

30652 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGE SURFACES. Kenneth Charles Melvyn Blower (to Atomic Power Constructions Ltd.). British Patent 926,728. May 22, 1963. Filed Sept. 14, 1960.

A design for heat-exchange surfaces particularly, but not exclusively, for reactor-fuel-element sheaths is patented. The cylindrical heat-exchange surface consists of an even number of longitudinally extending zones of helical fins, the pitch of the fins in each zone being of the opposite hand to that in adjacent zones. Fins to prevent the fuel element from bowing are provided at the junctions of the longitudinally extending zones. The bow-restraining fins are subjected to balanced forces from the coolant flow between the helical fins, and therefore they do not need extensive cross-bracing. Details of the design are described. (M.P.G.)

30653 A NEW OR IMPROVED PROCESS FOR THE MANUFACTURE OF MICROPOROUS METALLIC MEMBRANES. Roger Lacroix (to Commissariat à l'Énergie Atomique). British Patent 927,285. May 29, 1963. Priority date Aug. 30, 1958, France.

A method of producing a microporous membrane from an alloy including two metals is patented. The metal to be retained in the finished membrane is less soluble in an aqueous solution than the other metal and constitutes not more than 60% of the atoms of the alloy. The polarizing curves of the alloy and the metal to be retained must be distinctly different with respect to the aqueous solution, the polarizing curve of the alloy having a zone of potentials relatively less positive than that of the metal. A thin layer of the alloy is subjected to selective dissolution in the aqueous solution. The ions of the metal to be extracted are subjected to an electrical potential, either by adding to the solution a reduction-oxidation reagent of a redox potential more positive than the dissolution potential of the metal to be extracted, or by maintaining the alloy at an anode potential more positive than the dissolution potential of the metal to be extracted and more negative than that of the metal to be retained. The preparation of membranes of gold from gold–silver alloys and of silver from silver–zinc alloys is described. (M.P.G.)

30654 IMPROVEMENTS RELATING TO REMOTELY OPERABLE FLUID FLOW CONTROL VALVES. John Owen Tattersall and Peter Wraith (to United Kingdom Atomic Energy Authority). British Patent 927,331. May 29, 1963. Filed Apr. 10, 1961.

A remotely operable valve, which can be used at temperatures above 100°C to give access to the interior of a pressure vessel, is patented. The valve consists of a flap and a valve seat, on which the flap closes and seals. The area of seating contact lies wholly in one plane. The flap is opened and closed by a pivotally mounted hinge arm and drive transmissions, all on the same side of the seat. No operating mechanism passes through the wall containing the valve opening, thereby avoiding the use of sealing glands. Details of the design are described and illustrated. (M.P.G.)

30655 IMPROVEMENTS IN OR RELATING TO PACKAGE IRRADIATION SYSTEM. Sidney Jefferson (to United Kingdom Atomic Energy Authority). British Patent 930,326. July 3, 1963. Filed Apr. 25, 1960.

The uniform irradiation of packages can be achieved by repeatedly moving packages (equal size) arranged in columns or layers past a gamma source. On succeeding trips past the source, each package assumes a different space in the arrangement until it has occupied all the possible positions. (D.C.W.)

30656 IMPROVEMENTS IN OR RELATING TO STEAM GENERATING PLANT. Martin Honess Kendon (to Rolls-Royce Ltd.). British Patent 930,360. July 3, 1963. Filed Feb. 1, 1962.

A steam generating plant for marine vessels includes a steam superheater (nuclear reactor, perhaps) from which steam is ducted to the point of use (heat exchanger, etc.). A steam generator receiving the condensed steam from the point of use uses steam from the superheater to evaporate the condensate. The superheated steam used in the evaporation is compressed by a turbo-compressor and directed into the superheater. The condensate evaporated in the generator is used to drive the turbo-compressor. (D.C.W.)

30657 IMPROVEMENTS IN PRESSURE VESSELS. Frank Clifford and Charles Milburn White (to Whessoe Ltd.). British Patent 930,641. July 3, 1963. Filed Sept. 10, 1958.

Tight seals can be formed between the two parts in which a pressure vessel is constructed by forming adjacent rings and slots on the interior and exterior of the parts near and parallel to the edges to be joined. Steel plates on the interior and exterior of the vessel are positioned perpendicular to the joint and engage the slots and rings with corresponding rings and slots. Bolts through the plates and vessel tie the parts together. A curved cylindrical shell welded over this joint on the outside seals it. (D.C.W.)

30658 VARIABLE-THROW CAM. E. C. Godsil and Ernest Y. Robinson (to U. S. Atomic Energy Commission). U. S. Patent 3,097,543. July 16, 1963.

A variable-throw cam comprising inner and outer eccentric sleeves which are adjustably locked together is described. The cam throw is varied by unlocking the inner and outer sleeves, rotating the outer sleeve relative to the inner one until the desired throw is obtained, and locking the sleeves together again. The cam is useful in applications wherein a continuously-variable throw is required, e.g., ram-and-die pressing operations, cyclic fatigue testing of materials, etc. (AEC)

Heat Transfer and Fluid Flow

30659 (GEAP-3755) BURNOUT CONDITIONS FOR NONUNIFORMLY HEATED ROD IN ANNULAR GEOMETRY. WATER AT 1000 PSIA. E. Janssen and J. A. Kervinen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). June 1963. Contract AT(04-3)-189. 69p.

Tests were run to determine the burnout conditions for a nonuniformly heated rod in an annular geometry. Two special electrically heated rods were used; the cosine rod, which gave an approximate cosine axial heat flux distribution; and the truncated cosine rod, identical to the cosine, except for one end cut short. The rod to be tested was placed in a circular tube test section to form the annular flow path for the water coolant. Only the rod was heated; the outer surface (tube) was essentially adiabatic. Orientation was vertical, with flow upward. The tests were run at the following conditions: rod OD, 0.540 inch; tube ID, 0.875 inch; hydraulic diameter, 0.335 inch; heated length of cosine rod, 108 inches; heated length of truncated cosine, 91 inches; pressure, 1000 psia; flow rate, 0.84×10^6 to 1.40×10^6 lb/hr-ft^2; and steam quality at exit, 12 to 35%. For each flow and inlet subcooling, the electrical power was increased until burnout was reached, thus establishing a burnout condition. Each nonuniform rod was instrumented with thermocouples in the region of anticipated burnout. The local heat flux and local quality at each position at which a thermocouple indicated a temperature rise, were determined for each burnout run. The local heat flux at burnout was plotted versus the local quality at burnout, for the two nonuniform rods. The uniform rod burnout correlation was superposed for comparison. The nonuniform rod data points averaged from 9 to 20% low. The magnitude of this deviation is considered small, and of the same order as that for the uniform rod data upon which the correlation was originally based. It was concluded that the uniform rod burnout correlation can be used to predict burnout for cosine heat flux distribution. It is tacit in this conclusion that burnout depends only on local conditions of quality and flow. A method for predicting burnout for a nonuniform heat flux distribution was developed and applied to all the cosine and truncated cosine rod data. The predicted average heat flux at burnout is within +11%, −2.5% of the measured average heat flux. The method predicts the most probable position at which burnout will occur, and accurately predicts the power level at which burnout will occur. (auth)

30660 (GEAP-4275) TWO-PHASE PRESSURE LOSSES. Fifth Quarterly Progress Report, February 12, 1963–May 12, 1963. E. Janssen and J. A. Kervinen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1, 1963. Contract AT(04-3)-189. 24p.

Void measurements were made in the ½-inch by 1¾-inch rectangular channel, for both flow up and flow down, at pressures of 600, 1000, and 1400 psia and at various flows and qualities. Results at 1000 psia and 20 percent quality show that for the lowest flow (0.25×10^6 lb/hr-ft^2), the void fraction for flow down is much higher. However, when the flow is increased to 1.0×10^6 lb/hr-ft^2, both the void distribution and the average void for flow down tend to approach the corresponding values for flow up. At 1000 psia and 1.0×10^6 lb/hr-ft^2, both flow up and flow down, the void fraction for 5% quality increases gradually from the wall to the center of the channel, and peaks at the center. At 20% quality, the void fraction increases abruptly from the wall and tends to be constant over the middle 65% of the channel. The void fraction for flow down is always greater than for flow up, other things being equal. Results at 1.0×10^6 lb/hr-ft^2 flow up and 20% quality show that when the pressure is increased from 600 to 1400 psia, the void fraction decreases. A plot of average void versus quality at 1000 psia, various flows, shows that: the points at 1×10^6 and 2×10^6 lb/hr-ft^2 are in good agreement with Larson's results, and for flow up, flows less than 1×10^6 lb/hr-ft^2, the points lie below Larson's curve, the lower points corresponding generally to the lower flows. For flow down, the points generally lie above Larson's curve, the higher points corresponding to the lower flows. This is the flow effect noted earlier. (auth)

30661 (HW-65173(Rev.)) EFFECT OF WIRE WRAPS ON PRESSURE DROP FOR AXIAL TURBULENT FLOW THROUGH ROD BUNDLES. E. D. Waters (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1963. Contract AT(45-1)-1350. 35p.

Pressure drop was determined experimentally for adiabatic axial flow through rod bundle assemblies in a Reynold's number range from approximately 20,000 to 200,000. Bundles of seven and nineteen rods were used in round pipes. Using seven rod bundle assemblies, data were obtained to show pressure drop as a function of the pitch of wires wrapped spirally around each of the six outer rods. Wire wrap pitch was varied from 2 to 18 inches. Experimental data are correlated in terms of friction factors for nonwrapped bundles and drag coefficients for the wire wraps. Pressure drops calculated from these relations generally agree within ±10% of measured drops. Experimental friction factor values are compared with the Moody smooth tube values. (auth)

30662 (HW-SA-2772) STREAM FUNCTIONS FOR THREE-DIMENSIONAL FLOW IN HETEROGENEOUS POROUS MEDIA. R. William Nelson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 15, 1963. Contract AT(45-1)-1350. 20p.

A derivation of ground water stream functions for three-dimensional steady flow in heterogeneous porous media is presented. The path functions for transient flow in heterogeneous media are also derived. An application in conjunction with a computational scheme for in situ permeability measurements in heterogeneous media is included. (J.R.D.)

30663 (TID-19029) FLOW OF A HEAT-GENERATING FLUID IN A PARALLEL-PLATE CHANNEL. E. M. Sparrow, J. L. Novotny, and S. H. Lin (Minnesota. Univ., Minneapolis. Heat Transfer Lab.). [1962]. Contract AT (11-1)-659. 32p.

Heat transfer results for laminar flow of a heat-generating fluid in a parallel-plate channel were determined analytically and verified by experiment. The analysis was carried out for very general conditions which included either arbitrary longitudinal variations of wall temperature or wall heat flux along with arbitrary variations of the internal heat generation. The analytical results apply both in the thermal entrance region and the fully-developed region. Experiments carried out utilizing an electrolyte heated internally by ohmic heating agreed well with the theory. (auth)

30664 (TID-19089) BASIC EXPERIMENTAL STUDIES OF BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES. Monthly Progress Report, June 1963. B. Matzner and J. Griffel (Columbia Univ., New York. Engineering Research Labs.). June 28, 1963. Contract AT(30-3)-187. 12p. (MPR-XIII-6-63)

The data previously obtained for burnout inside large diameter tubes (1.475", 0.930" and 0.504") at 1000 psia are replotted to show the effect of diameter on burnout heat flux. The results show that above a mass velocity of 2.8×10^6 lb/hr-ft^2 at constant exit steam quality there is practically no effect of diameter on burnout heat flux. As the mass velocity is decreased below 2.8×10^6 lb/hr-ft^2 there is an increasingly strong reduction in burnout heat flux as the diameter is increased at constant exit steam quality. The above data for tubes with a heated length of about 77" are also compared to the data from a 0.930" ID tube with a 24" heated length. It is shown that at a constant exit quality burnout heat flux decreases with increasing length and that the effect is less pronounced with increasing mass velocity. (auth)

30665 (TID-19090) HEAT TRANSFER IN RECTANGULAR DUCTS WITH TWO HEATED AND TWO UNHEATED WALLS. J. L. Novotny, S. T. McComas, E. M. Sparrow, and E. R. G. Eckert (Minnesota. Univ., Minneapolis. Heat Transfer Lab.). Apr. 1963. Contract AT(11-1)-659. 54p. (HTL-TR-52)

The fully developed heat transfer characteristics for air flowing in rectangular ducts of aspect ratio 1:1, 5:1, and 10:1 were determined experimentally for the case in which one pair of walls is uniformly heated and the other pair is unheated. The results cover the Reynolds number range from 11,000 to 140,000. The Nusselt numbers of the experiment were in satisfactory agreement with an analysis for the parallel-plate channel, with the largest deviations (~12%) between theory and experiment occurring in the range of low Reynolds numbers. The circular tube analysis also agreed satisfactorily with the data. For all of the ducts, the thermal entrance region appeared not to exceed 30 hydraulic diameters within the Reynolds number range of the experiment. The influence of spanwise heat conduction from the heated walls into the unheated walls was evident. (M.C.G)

30666 (WCAP-1997(Rev.2)) NEW DNB (BURNOUT) CORRELATIONS. L. S. Tong, H. B. Currin, and A. G. Thorp, II (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). May 1963. Contract AT(30-1)-3064. 47p.

As a result of a parametric study of about 3000 published DNB (departure from nucleate boiling) data points, two DNB correlations were developed for the sub-cooled region and the quality region, respectively, pending further experimental verification. The validity of the correlations in the ranges of various parameters were examined by plotting the ratios of (ΔH_{DNB} measured/ΔH_{DNB} predicted) and (q''_{DNB} measured/q''_{DNB} predicted) versus various physical parameters in the ranges of application. The results show that there are no trends due to these parameters other than those already incorporated into the correlations. A future test on DNB is described. Joint planning and systematic coordination are suggested for future DNB tests. (auth)

30667 GROWTH OF A VAPOUR FILM AT A RAPIDLY HEATED PLANE SURFACE. T. D. Hamill and S. G. Bankoff (Northwestern Univ., Evanston, Ill.). Chem. Eng. Sci., 18: 355-63(June 1963). (In English)

An apparently new similarity transformation is presented for a class of extended one-dimensional Stefan problems involving phase density variations, such as vaporization of liquid at the surface of a rapidly heated plate. After transforming to Lagrangian coordinates, a similarity variable is introduced, and appropriate initial and boundary conditions deduced. The resulting ordinary differential equation is numerically integrated, and is also solved by a method of successive approximations after conversion into a nonlinear Volterra integral equation. Solutions are presented for both saturated and subcooled initial liquid temperatures. (auth)

30668 HEAT TRANSFER WITH LIQUID MERCURY FLOW IN CIRCULAR TUBES. V. I. Subbotin, P. A. Ushakov, B. N. Gabrianovich, V. D. Talanov, and I. P. Sviridenko (Obninsk Inst. of Physics and Power Engineering, USSR). Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 4, 16-21(Apr. 1963). (In Russian)

It was determined that the Nusselt numbers for Hg and the eutectic alloy Na–K flowing in circular tubes with various heat transfer surfaces are in good agreement. An empirical formula obtained in a wide range of Pe numbers may be used to estimate heat transfer coefficients of refined liquid metals. (auth)

30669 OPERATING CONDITIONS IN A MAGNETOHYDRODYNAMIC CHANNEL. E. P. Zimin (Krzhizhanovskii Inst. of Power Engineering, Moscow). Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 4, 92-5(Apr. 1963). (In Russian)

An electrically conducting fluid flow between flat parallel plates was considered, and a uniform magnetic field normal to the plates was analyzed. The analysis revealed four regions, two of which (I, III) are the brake regions (power is supplied from an external source and there is a pressure drop along the channel), and the others (II, IV) are regions of a pump and a generator. (auth)

30670 LAMINAR TWO-PHASE BOUNDARY LAYERS IN NATURAL CONVECTION FILM BOILING. Traugott H. K. Frederking (Eidgenössische Technische Hochschule, Zurich). Z. Angew. Math. Phys., 14: 207-18(1963). (In English)

A steady laminar two-phase boundary layer in film boiling on a vertical plate is considered along with that on a vertical cylinder. Film-boiling solutions are given including the influence of momentum transport at the vapor-liquid interface and covering the whole range of vapor superheat up to the highest values which are physically possible in pure conductive heat transfer. Calculations are compared with experimental results. (M.C.G.)

30671 QUASI-ONE-DIMENSIONAL MAGNETOHYDRODYNAMIC FLOW WITH HEAT ADDITION. Roy M. Gundersen (Illinois Inst. of Tech., Chicago). Z. Angew. Math. Phys., 14: 294-6(1963). (In English)

A method is presented for discussing quasi-one-dimensional magnetohydrodynamic flows, subjected to a transverse magnetic field, with heat addition. A system of equations, in which only derivatives of entropy along a particle path appear, was linearized in the neighborhood of a known isentropic state, and general solutions were obtained. (M.C.G.)

30672 AN ELECTRON BEAM EXCITATION TECHNIQUE FOR THE MEASUREMENT OF LOW DENSITIES IN HYPERSONIC SHOCK TUNNEL FLOWS. R. E. Zempel, J. R. Mallin, and E. P. Muntz (General Electric Co., Valley Forge, Penna.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint CP 63-599, 18p, $1.00. (CONF-2-5)

From Winter General Meeting, New York, 1963.

A system designed for the measurement of gas densities in low density hypersonic flows is described. The operating procedure for the equipment is outlined. Results from shock tunnel experiments are presented. Measured free stream densities in the shock tunnel compares favorably with other more indirect ways for obtaining the same parameter. Also, an example of the use of the system for measuring densities in the near wake region of a model re-entry vehicle is given. The system is capable of providing time resolved, "point" (one mm cube) measurements of density. The upper density limit of about 2.0×10^{-4} lb/ft^3 (this is for room temperature air) is inherent in the excitation-emission process. The lower density limit of approximately 2.5×10^{-6} lb/ft^3 for the present system is purely a function of the system's optical speed and the photomultiplier sensitivity. Using a slightly modified optical set-up, densities as low as 4.0×10^{-7} lb/ft^3 have been measured at the Space Sciences Laboratory. It is known that measurements of at least one order of magnitude less density would present no difficulty. (auth)

30673 FULLY-DEVELOPED, NON-NEWTONIAN, MAGNETOHYDRODYNAMIC FLOW OF AN INCOMPRESSIBLE FLUID IN AN INFINITELY-WIDE FLAT DUCT. Blaine Irvin Leidy. Thesis, Pittsburgh, Univ. of Pittsburgh, 1962. 168p.

The classical magnetohydrodynamic problem of Hartmann is extended to a restricted type of non-Newtonian fluid in which shearing stress is a cubic function of the rate of shearing strain. The two principal parameters of the flow system then become the Hartmann Number, M, and a dimensionless parameter, A_2. The latter involves the conventional absolute viscosity and an undefined physical property that is the coefficient on the cubic term in the stress-rate of strain relation. It is shown that values of A_2 equal to or less than $\frac{1}{9}$ and greater than negative infinity are compatible with the condition of fully-developed, laminar flow for any Hartmann Number equal to or greater than zero. Dimensionless solutions, sometimes in parametric form, are found for velocity, temperature, and magnetic field strength distributions. Also, axial pressure and temperature gradients and average velocities are found in dimensionless form for the valid ranges of M and A_2. Several graphs of representative results are given and discussed with regard to the separate effects of the two main parameters. Of the infinite number of combinations of the parameters A_2 and M that are considered, a special family is found in which A_2 and M are not independent of each other. The results for this family are only slightly more complex than those for the classical flow condition of $A_2 = M = 0$, and the latter is readily shown to be a limiting case. In the more general combinations of A_2 and M, elliptic integrals are solved and a trial and error technique is used to establish an unknown constant, K. Accuracy of results is dependent only upon the accuracy of this constant, the normal difficulty of interpolation in the elliptic integral tables, and the number of significant figures carried along in the calculations. (auth)

30674 IMPROVEMENTS IN OR RELATING TO FLUID FLOW CONTROL APPARATUS. Walter John Cairns and Wyndham Morgan John (to United Kingdom Atomic Energy Authority). British Patent 924,733. May 1, 1963. Filed July 24, 1959.

An apparatus for the change-over of fluid flow between inner and outer ducts of tube assemblies is patented. The apparatus consists of coaxial tubes, the inner tube being spaced from the outer tube to form an annular duct. At least 2 separate passages establish communication between the interior of the inner tube and the annular duct, and a baffle constrains the fluid to be changed over from the inner tube to the annular duct without flow reversal. The apparatus has particular application in coaxial tube loop assemblies for testing materials in reactors, where the coolant must flow from the inner to the outer tube. (M.P.G.)

Materials Testing

Refer also to abstracts 29891, 30061, 30067, 30068, 30147, and 30156.

30675 (ORNL-3448) EQUIPMENT FOR HARDNESS TESTING AT ELEVATED TEMPERATURES. George Hallerman and R. J. Gray (Oak Ridge National Lab., Tenn.). July 31, 1963. Contract W-7405-eng-26. 30p.

The design and testing procedures of two elevated-temperature hardness testers are described. One device uses a Rockwell tester with a large vertical capacity and a load range of 15 to 150 kg. The tester is equipped with a 900°C heating chamber which maintains an argon atmosphere over the specimen and can be laterally displaced by a cross-feed mechanism to allow repeated hardness readings to be made on the same specimen. The second instrument is a microindentation hardness tester for hardness determinations to a maximum temperature of 1000°C in vacuum of 10^{-4} to 10^{-5} torr. A deadweight loading system with a 136-deg diamond pyramid (Vickers) indenter, capable of delivering static loads between 0.150 and 3 kg, is contained within the vacuum chamber to avoid calibration problems that arise when loads are applied from outside the vacuum system. The microindentation hardness tester allows up to 100 determinations to be made on a single specimen without opening the test chamber. The applicability of the testers is illustrated by elevated-temperature hardness measurements on several commercial alloys, a group of niobium–vanadium alloys, and

by the changes in hardness occurring at the transformation temperatures of iron and steel. Hardness values of Haynes alloy No. 25 were determined at the temperatures of aging and are shown to be different from those obtained with the customary method of investigating age hardening. The testing is currently being used to aid and accelerate the development of alloys with desirable high-temperature properties. (auth)

30676 (TID-19009) A SYSTEM FOR EMPLOYING ULTRASONIC IMAGING TECHNIQUES FOR NONDESTRUCTIVE TESTING. Final Report. John E. Jacobs (Northwestern Univ., Evanston, Ill. Technological Inst.). June 28, 1963. For Argonne National Lab., Ill. Contract W-31-109-eng-38. 25p.

Both practically and theoretically, configurations for ultrasonic image-forming transducers are investigated. Construction techniques and applicability of the piezoelectric form of the ultrasonic image converter are given. The work has resulted in the development of a technique for producing sealed-off tubes and the demonstration of the feasibility of cinesonography in detecting non-bonds, fluid flow patterns, and defects in welded structures. (N.W.R.)

30677 NEUTRON RADIOGRAPHY IN FIELD USE. Edward A. Warman (General Dynamics Corp., Groton, Conn.). 40p. (CONF-41-1)

From National Convention of the Society for Nondestructive Testing, Oct. 1962, New York.

Some of the basic aspects of neutron radiography are reviewed with particular emphasis on the physics of this nondestructive testing method. The results of an experimental evaluation program are presented which show conclusively that isotopic antimony-beryllium photoneutron sources can be used for neutron radiographic applications. This program provided valuable new information regarding neutron moderation and beam collimation requirements. Based on this experimental evidence, a portable device was designed and is described. The device employs a portable radiographic camera, with an antimony-beryllium photoneutron source, in conjunction with a neutron moderator and beam collimator configuration. This development makes available, for the first time, a means of obtaining economical inspection neutron radiographs in field application usage. (auth)

30678 IMPROVEMENTS IN OR RELATING TO MAGNETIC TEST PARTICLES. John Dayton Steele. British Patent 927,492. May 29, 1963. Priority date Aug. 3, 1959, United States.

A magnetic flux system of nondestructive testing is patented, which reduces the change of human failure in the detection of flaws. A powder is prepared of a paramagnetic (or ferromagnetic) material, a carrier of chelating or ion-exchanging material, and a synthetic resin to bond the carrier to the paramagnetic material. The particles of the powder are dispersed in a medium containing radioactive materials, which become attached to the powder by adsorption or chemical reaction. When the paramagnetic radioactive powder is flushed over a body, in which a magnetic flux has been created, the powder particles will concentrate in the area of flaws in the body, since the magnetic flux is intensified in that area. The flaws can then be detected by radioactive detectors. Details of the invention, including components and preparation of the powder, are described. (M.P.G.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

Refer also to abstracts 29984, 30034, 30090, 30091, and 30662.

30679 (RME-4543) THE SAYAPULLO MINE AREA, CAJAMARCA DEPARTMENT, PERU. John W. Gabelman (Division of Raw Materials, AEC). July 1959. 17p.

The Sayapullo copper mine on Cerro Carmen Alto is on the faulted common limb between a large anticline and syncline in Cretaceous interbedded sandstone, limestone, and shale. Intrusives are rare. Cerro Carmen Alto is an intensely silicified body of sediments and the largest of abundant pipes of argillized and silicified rocks in the area. A system of east-west-striking veins nearly parallels the sediments. Wide veins contain mostly chalcopyrite, whereas narrow veins contain tetrahedrite, chalcopyrite, galena, and sphalerite. Although the entire mine area has high background radioactivity and weak anomalies are associated with several alteration pipes, only a small amount of uraninite is associated with tetrahedrite in the Clavo Jackson ore shoot on the Restauradora vein and apparently in a short segment of the Florida vein. (auth)

30680 (RME-4567(Rev.)) RECONNAISSANCE FOR URANIUM IN THE SAN PEDRO DE ATACAMA AND LACO AREAS, PROVINCE OF ANTOFAGASTA, CHILE. Paul H. Knowles, William A. Bowes, Mario Serrano C., and Aldo Moraga B. (Division of Raw Materials, AEC and Chile. Instituto de Investigaciones Geologicas, Santiago). Dec. 1961. 21p.

A reconnaissance for uranium in and a general geologic study of the San Pedro de Atacama and Laco areas of northern Chile disclosed no significant radioactivity in the Laco area, but near San Pedro de Atacama slight anomalies were detected in limey silts of the San Pedro formation. (auth)

30681 METHODS FOR MEASURING THE NATURAL RADIOACTIVITY OF THE ATMOSPHERE. Dragos Blănariu. Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn., 12: 95-109(1961). (In Rumanian)

The radioactivity of the atmosphere, discovered in 1901 by J. Elster and H. Geitel, is due to the thoron and radon formed by the natural radioactive decay chains. The daughter products of the radioactive gases, being mostly heavy metals, settle on dust particles and form highly mobile aerosols. The equilibrium between the Tn and Rn and their daughters is disturbed near the ground level; RaA reaches equilibrium at 1 to 2m, RaC at a height of 10 to 20m above ground. The settling time of the naturally radioactive aerosols is about 10 days; this accounts for the low activity of the long-lived products in the atmosphere. The other natural radioactive elements in the atmosphere are C^{14}, H^3, and Be^7, created by the bombardment of N, H, and O atoms by cosmic radiation. The atmosphere also contains radioactive fission products from atomic explosions. The radioactivity varies from place to place; over dry land near ground level the average Rn activity is about 10^{-15} C/l, the Tn activity 10^{-17} C/l. Over the oceans the activity is decreased by about 1 or 2 orders of magnitude. Direct methods, e.g., with ionization chambers, and more often indirect methods are used for measurements. The filtration methods were greatly improved and their efficiency approaches 100%; the electrostatic precipitation presents, however, the advantage of yielding a deposit with a higher activity and being independent of the particle-size spectrum; the possible flow rate may exceed the 50 m^3/hr which is the maximum with filters. (111 references) (TTT)

30682 CARBON-14 IN NATURE AND ITS DETECTION. Ion Viscrian. Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn., 12: 111-20(1961). (In Rumanian)

Interaction between cosmic radiation and atoms of the air results in the disintegration of these atoms and formation of neutrons; the density of the latter increases with altitude up to 15 km, after which it decreases suddenly. The neutrons disintegrate with a half life of 13 minutes into protons; thus, they cannot be due to primary cosmic radiation. The neutrons form C^{14} according to the (n,p) reaction ${}_7N^{14} + {}_0n^1 \rightarrow {}_6C^{14} + {}_1P^1$, with a slow neutron cross section of 1.7 barn. It is estimated that 144 C^{14} atoms are created every minute over every cm^2 of the earth's surface. The ratio of C^{14} to ordinary C, consisting of 98.89% C^{12} and 1.11% C^{13}, is 1.3×10^{-12}; its half life is 5560 ± 30 years. As a result of photosynthesis, all plants absorb C^{14} from the atmospheric CO_2. The calculated specific activity of 17.3 disintegrations/minute agrees well with the experimental value of 15.3, found for organic materials. As the assimilation of C^{14} stops with the death of the living material, its determination may be used for the calculation of the age of the material, assuming that the intensity of the cosmic radiation did not change noticeably during the decay period. The activity is measured by G-M, proportional, or scintillation counters. Liquid scintillators yield the best results at present. For archeological studies, in which usually only a small sample is available, the use of proportional counters filled with labeled CO_2 is recommended. (TTT)

30683 AN ATTEMPT TO EXPLAIN TEMPORARY VARIATIONS IN GROUND AIR-LAYER POLLUTION IN CENTRAL EUROPE BY RADIOACTIVE SUBSTANCES DERIVING FROM NUCLEAR EXPLOSIONS. Teodor Kopcewicz. Acta Geophys. Polon., 10: 299-334(1962).

An analysis is given of the results of ground-level radioactive pollution measurements carried out during the period October 1958 to July 1959 at five Central European stations: Mol, Riso, Berlin, Vienna, and Legionowo (Poland). Two types of radioactive pollution are distinguished: transient and long-term, the latter being defined as lasting at least several days. Assuming that pollution is due to radioactive dust which entered the warm troposphere from the cold stratosphere through gaps in the tropopause during non-tropical cyclones, meteorological conditions are given for the occurrence of transient and long-term pollution and two examples of long-term pollution in Central Europe are discussed. The examples concern the periods January 16 to 23 and March 16 to 24, 1959. The transient pollution is found to occur when the front of a cyclone passes over the recording station. The long-term pollution is due to an extensive and long-lived source of radioactive dust to the west of the western and north-western European coast. This source was formed by penetration through tropopause gaps in the cold-front regions of secondary cyclones which form at the quasistationary polar front over the northeastern Atlantic. Using upper and ground-level synoptic charts for the North Hemisphere, published by the USSR Central Institute of Weather Forecasting, it is shown

that the meteorological data fit the hypotheses put forward. Cyclic variations of the amount of pollutant are established and the periods match the cyclic changes of pressure and temperature. An explanation of the annual variation of pollution is given for middle latitudes in relation to the annual variation of the meteorological data. (OTS)

30684 A NOTE OF THE RADIOACTIVITY OF POLISH MINERAL WATERS. [PART] II. Ignacy Zlotowski and Maria Rymaszewska (Univ. of Warsaw). Acta Geophys. Polon., 11: 59-65(1963). (In Polish)

The alpha radioactivity of solid residues obtained by evaporation of two mineral waters from Polish spas ("Staropolanka" and "Anka") was investigated. The results are compared with the maximum permissible concentration (MPC) of alpha emitters in drinking water. (auth)

30685 THE ENERGY DISTRIBUTION OF RADIOISOTOPES IN GROUND-WATER FLOW. C. Torre (Bundesversuchsund Forschungsanstalt Arsenal, Vienna). Atomkernenergie, 8: 226-31(June 1963). (In German)

The amount of the subsoil water-flow can be investigated by radioactive tracers. A mathematical method was developed in connection with a tracer method. This theory considers the analogy to the thermal boundary layer hydrodynamics. Because the compressibility of subsoil water was neglected, the energy distribution was computed around a circular cylindrical hole without connection to hydrodynamical equations. In the stationary case, an energy distribution similar to the normal probability function, which shows in polar co-ordinate system a cardioid-like form, was obtained. (auth)

30686 CONCENTRATION OF NATURAL AND ARTIFICIAL AIRBORNE ACTIVITIES NEAR GROUND LEVEL AT WINNIPEG. R. D. Connor (Univ. of Manitoba, Winnipeg). Can. J. Phys., 41: 1118-34(July 1963).

Concentrations of radon, thoron, and particulate fallout are evaluated on a day-to-day basis from December 1958 to May 1962, especially for the period subsequent to the Russian tests in the fall of 1961. The efficiency of the filter used for the collection of aerosols carrying active deposits of radium and thorium is determined as 98.2 ± 0.8%. The magnitude and extent of the corrections applied to the data are discussed in detail and the results for the fallout concentration at Winnipeg are analyzed. The decay of fresh fallout is followed for periods up to two months and a correlation between the date of explosion and the occurence of a peak in the fallout concentration is indicated. (auth)

30687 IMPLICATIONS OF THE MINOR ELEMENT CONTENT OF SOME MAJOR STREAMS OF THE WORLD. W. H. Durum and Joseph Haffty (Geological Survey, Washington, D. C.). Geochim. Cosmochim. Acta, 27: 1-11(Jan. 1963). (In English)

Of 15 or more minor elements in the world's principal river waters, only aluminum, iron, manganese, barium, and strontium range much over 100 μg/l (parts per billion). Most minor elements range at or below 100 μg/l and have median (or middle) values of 10 micrograms per liter or less. Significant areal differences in minor element content are found in the river waters. For example, Atlantic Coastal river waters in the aggregate are slightly more enriched in concentrations of silver, chromium, manganese, molybdenum, nickel, strontium, and titanium, and slightly deficient in barium and lithium when compared with median values for North America. Median values of ratios Ba/Sr, Ni/Cr and Ni/Cu are reasonably consistent (within a factor of two) in principal drainage from North America. Noteworthy are consistent median ratios of Ni/Cu for large rivers of United States, but the ratio tends to be slightly greater in global northern latitudes than in southern latitudes. Median values for aluminum, barium, copper, lead, molybdenum, and silver in North American runoff are of the same order as published world averages for ocean water. Hydrologic and geochemical aspects of continental runoff are strongly implied in observations of minor element content of large rivers. Evidence to date is that median values of Ba/Sr ratios are relatively uniform in global river waters. There is real danger in oversimplifying chemical systems in broad assessments of lower reaches of large drainage basins because individual hydrologic and chemical events upstream are largely obscured. (auth)

30688 RARE GASES AND POTASSIUM DETERMINATION IN A LARGE SAMPLE OF STONY METEORITES. T. Kirsten, D. Krankowsky, and J. Zaehringer (Max-Planck-Institut für Kernphysik, Heidelberg). Geochim. Cosmochim. Acta, 27: 13-42(Jan. 1963). (In German)

The He, Ne, and Ar isotopes of 59 and the total K content of 48 stony meteorites were determined. The isotopic composition of the spallation-produced rare gases is in agreement with production rates, calculated from the cosmic ray spectrum including secondaries and from cross-section measurements of high-energy protons. Different chemical composition of the various types of stony meteorites can account for the large variations of the measured isotopic ratios. In some cases a different effective bombarding energy due to the amount of shielding is indicated. The distribution of the amount of spallation products points to a continuous breaking of the meteorites rather than to a single event. The He and K–Ar ages range from 0.2 to 5.1×10^9 yr and have a maximum in their distribution around $4,5 \times 10^9$ yr. A considerable number of meteorites have ages below 2×10^9 yr and some have large differences between the He and K–Ar ages. This can only be explained by an additional heating source after their formation. Heating by collisions seems to be more likely than by solar radiation. (auth)

30689 DEUTERIUM IN ICELAND WATERS. Irving Friedman (Geological Survey, Denver), Thorbjoern Sigurgeirsson, and Oern Gardarsson. Geochim. Cosmochim. Acta, 27: 553-61(June 1963). (In English)

From the deuterium analysis of 159 samples of water collected in Iceland from hot-water boreholes, cold and hot springs, rivers, and rain, the geographical distribution of deuterium in surface waters is plotted. On the basis of the deuterium analysis, the water from boreholes near Reykjavik does not originate from local precipitation. The variation of deuterium content of these water wells with time suggests that these data can be used to determine the time of travel of recharge water to the various boreholes, as well as the surface recharge area. (auth)

30690 ABUNDANCES OF THE FOURTEEN RARE-EARTH ELEMENTS, SCANDIUM, AND YTTRIUM IN METEORITIC AND TERRESTRIAL MATTER. R. A. Schmitt, R. H. Smith, J. E. Lasch, A. W. Mosen, D. A. Olehy, and J. Vasilevskis (General Dynamics Corp., General Atomic Div., San Diego, Calif.). Geochim. Cosmochim. Acta, 27: 577-622(June 1963). (In English)

Abundances and isotopic ratios were determined for the fourteen rare-earth elements (REE) (Pm excluded) plus Sc and Y by neutron-activation analysis in nineteen meteorites and in three terrestrial specimens. The meteorites

investigated included eleven chondrites (1 carbonaceous, 2 pigeonitic, 2 hypersthenic, 3 bronzitic, and 3 enstatitic), two calcium-rich and three calcium-poor achondrites, one mesosiderite and two iron meteorites; the terrestrial specimens included a fresh volcanic basalt, and a deep-seated peridotitic, and an eclogitic specimen. The absolute abundance of a typical REE (La) in bronzitic and hypersthenic chondrites was found to be 0.34 ppm. Relative REE, Sc, and Y distributions were identical in the five different chondrite categories. On an absolute basis, the REE, Sc, and Y per 10^6 Si atoms varied monotonically over the chondrite spectrum, i.e., from carbonaceous through enstatitic meteorites. Meteoritic isotopic abundances of the sensitive Yb^{168}/Yb^{174} ratio agreed to within ±5 per cent of the terrestrial abundance ratios. Absolute REE abundances in the two calcium-rich achondrites, Nuevo Laredo and Pasamonte, were from 10 to 12 times greater than the average chondritic values. No REE fractionation was found in these achondrites; however, Sc was fractionated by a factor of ~2 relative to the REE. Fractionation of the REE, Sc, and Y was found in all three calcium-poor achondrites, Johnstown, Shalka and Norton County, relative to the chondritic meteorites. Absolute REE, Sc, and Y abundances varied from 0.05 to 0.5 times the comparable values in chondrites. Eu has been depleted in Johnstown and Norton County by 3 to 4 times. Th has been depleted in Johnstown to the same degree as La. No REE and Y fractionation was found in the mesosiderite, Estherville; however, Sc has been fractionated. Absolute REE abundances in the two Fe meteorites were $\sim 10^{-4}$ times the REE abundances in chondrites. In one iron, the REE may have been fractionated. Absolute REE, Sc, and Y abundances in the uneroded Kilauea Iki-22 basalt, periodotitic, and eclogitic specimens were from 30 to 10 times greater than the abundances in chondrites. Compared with chondrites, the light REE have been enriched by factors of up to 5, which agrees with the enrichments of the light REE in terrestrial sediments and igneous rocks, etc. Theoretical calculations of expected REE abundances by Clayton et al. agree well with the present chondritic REE values. (auth)

30691 THE ABUNDANCE OF SCANDIUM IN VOLCANIC ROCKS, A PRELIMINARY ESTIMATE. Verne C. Fryklund, Jr. and Michael Fleischer. Geochim. Cosmochim. Acta, 27: 643-64(June 1963). (In English)

Using Rittman's classification to determine the clan, the following abundance figures are suggested: basalts (99), 38 ppm Sc; andesites (72), 34 ppm Sc; dacites (68), 21 ppm Sc; rhyodacites (32), 14 ppm Sc; quartz latites (14), 11 ppm; rhyolites (24), 5 ppm. The scandium was determined spectrographically on samples for which there were complete rock analyses. In addition, it is suggested that extrusive equivalents of peridotites should contain about 9 ppm. Sc; extrusive equivalents of perknites should contain about 30 ppm Sc. No reason is seen why these figures should not apply to the intrusive equivalents. A figure of 30 ppm for Sc for the crust is tentatively suggested, using Poldervaart's suggested ratio of rock types. (auth)

30692 TRITIUM AND DEUTERIUM CONTENT OF ATMOSPHERIC HYDROGEN. D. Ehhalt, G. Israel, W. Roether, and W. Stich (Universität, Heidelberg). J. Geophys. Res., 68: 3747-51(July 1, 1963).

A substantial increase of man-made tritium in atmospheric hydrogen was first reported by Gonsior in 1959. Begemann and Friedman, also in 1959, pointed out that admixture of industrial hydrogen causes large fluctuations in specific tritium activity. In further measurements Gonsior was able to show that in at least a few cases large activity peaks were directly due to test explosions, thus suggesting that unburned tritium leaves the fire ball. A series of new measurements on the hydrogen extracted directly from raw neon samples shows quantitatively that admixture of industrial hydrogen has indeed a serious effect. In many cases, however, a correction by means of a deuterium assay as suggested by Begemann and Friedman seems practicable. The corrected values show a steady and relatively steep rise in tritium up to 10^6 TU in 1962. As there was an extended gap in the test series between 1958 and 1961, this behavior points to an additional source of tritium, presumably the nuclear industry, as is the case with Kr^{85}. (auth)

30693 MEASUREMENTS OF THE TRITIUM AND DEUTERIUM CONCENTRATION IN ATMOSPHERIC HYDROGEN. B. Gonsior (Universität, Cologne), I. Friedman, and D. Ehhalt. J. Geophys. Res., 68: 3753-6(July 1, 1963).

Tritium and deuterium measurements were made on closely spaced samples of atmospheric hydrogen collected from August 1957 through January 1958. Some of the variations in tritium concentration were also shown by the deuterium variations. These variations in concentration of tritium and deuterium can be explained by admixture of industrial hydrogen, as suggested by Begemann and Friedman. However, there were also large rapid variations in tritium concentration that did not correlate with changes in deuterium, and these tritium peaks appear in samples collected in Germany several days after known Soviet H-bomb explosions. (auth)

30694 THE TRITIUM CONTENT OF ATMOSPHERIC HYDROGEN AND ATMOSPHERIC METHANE. F. Begemann (Max-Planck-Institut für Chemie, Mainz). J. Geophys. Res., 68: 3757-8(July 1, 1963).

The tritium content of atmospheric hydrogen was found to be much higher than that of tropospheric moisture. Addition of man-made tritium was also noted to have increased the tritium content of molecular H by a factor of 20, while the amount of tritiated H remained within a factor of five. The tritium content of northern hemispheric tropospheric CH_4 was higher than that of CH_4 from the stratosphere and the southern troposphere, suggesting an origin of tritium in the northern hemisphere. (D.C.W.)

30695 ON THE INVENTORY OF ARTIFICIAL TRITIUM AND ITS OCCURRENCE IN ATMOSPHERIC METHANE. E. A. Martell (National Center for Atmospheric Research, Boulder, Colo.). J. Geophys. Res., 68: 3759-69 (July 1, 1963).

Consideration of the bomb-produced tritium inventory and features of the budget and distribution of tritium in atmospheric water vapor, hydrogen, and methane provides a basis for rejecting previous explanations for the incorporation of artificial tritium into atmospheric methane. It is concluded that tritiated hydrogen is produced in thermonuclear clouds by radiative dissociation of water under oxidizing conditions. The occurrence of tritiated methane is explained by tropospheric exchange of methane with tritiated hydrogen that has mixed downward from the stratosphere. Chemical and energy criteria for the exchange of methane and hydrogen in the lower atmosphere are discussed. High tritium concentration of formaldehyde from thunderstorm rains is predicted. The possibility of equilibrium isotope exchange between tritiated water and tritiated hydrogen in thermonuclear clouds and in the upper atmosphere is also noted. (auth)

30696 SEASONAL VARIATIONS OF BOMB-PRODUCED TRITIUM IN RAIN. G. Israel, W. Roether, and G. Schumann (Universität, Heidelberg). J. Geophys. Res., 68: 3771-3(July 1, 1963).

The tritium activity of precipitation at Sindorf, Germany, was measured from March 1960 to December 1961. Regular seasonal variations were noted with maximums in May and June and a minimum in Nov. 1960. The activity was observed to rise after the bomb tests in the fall of 1961. The rise in Sr^{90} activity preceded the T increase by about two months. The peak of Sr^{90} in air also appeared nearly two months after the Sr^{90} peak in water. Heavy precipitation apparently does not lower the tritium activity of rain. (D.C.W.)

30697 DEUTERIUM AND OXYGEN 18 IN RAIN WATER. D. Ehhalt, K. Knott, J. F. Nagel, and J. C. Vogel (Universität, Heidelberg). J. Geophys. Res., 68: 3775-80 (July 1, 1963).

The D and O^{18} contents of rain water are known to vary considerably with time and location. Dansgaard found a good correlation of the mean O^{18} content of rain with mean air temperature, which causes a latitudinal as well as a seasonal variation of O^{18} and a similar one for D. Under dry climatic conditions, as in South Africa, the D content appears to be strongly influenced by re-evaporation of the falling raindrops. This has the effect of obscuring the normal seasonal variations. The evaporation obviously takes place under kinetic conditions, thus increasing the separation factors especially for the oxygen isotopes. A detailed study of a thunderstorm in Heidelberg shows that here too evaporation causes an enrichment in D. (auth)

30698 TRITIUM IN THE NORTH PACIFIC SURFACE WATER. A. E. Bainbridge (Univ. of California, San Diego). J. Geophys. Res., 68: 3785-9(July 1, 1963).

Regular measurements of tritium in the surface water of the North Pacific during the period 1960–1961 indicate that the residence time in this layer, on the basis of a simple "box" model, is less than 3.5 years. If the average depth of this layer is assumed to be 75 meters, precipitation contributes one-half of the input to the system. Alternatively, if precipitation is the only source, the effective depth to which this tritium is being mixed is about 40 meters. The total amount of tritium deposited in the northern hemisphere is estimated to be about 40 kilograms. (auth)

30699 SNOW STRATIGRAPHY AND OXYGEN ISOTOPE VARIATIONS IN THE GLACIOLOGICAL PIT OF KING BAUDOUIN STATION, QUEEN MAUD LAND, ANTARCTICA. R. Gonfiantini (Università, Pisa, Italy), V. Togliatti, E. Tongiorgi, W. De Breuck, and E. Picciotto). J. Geophys. Res., 68: 3791-8(July 1, 1963).

O^{18}/O^{16} ratios were measured along a firn profile extending from the surface to a depth of 16 m in the shelf ice of King Baudouin station (East Antarctica, 70°26′S, 24°19′E). Periodical variations are found that are believed to reflect the seasonal variations in the O^{18}/O^{16} ratio of precipitations. They allow the identification of annual layers following the method suggested by Epstein and Sharp. The oxygen isotope variations are compared with the stratigraphic features of the same profile. The notion "winter" or "summer" layers is shown to be meaningless when the layers are derived from stratigraphic criteria only. Very often the fine-grained unmetamorphosed layers (generally called "winter" layers) are made up of snow with high O^{18} content which must represent summer precipitation. On the other hand, the coarse-grained recrystallized layers ("summer" layers) often display a minimum O^{18} content and are composed of snow that fell in the winter. Identification of annual layers involves a similar degree of uncertainty from personal interpretation in the stratigraphic method as well as in the isotope ratio method, but the two methods are complementary, being affected differently by natural circumstances. A good agreement is found between the average accumulation rates deduced from both methods. (auth)

30700 THE VERTICAL DISTRIBUTION OF RADON 222, RADON 220 AND THEIR DECAY PRODUCTS IN THE ATMOSPHERE. W. Jacobi and K. André (Hahn-Meitner-Institut für Kernforschung, Berlin). J. Geophys. Res., 68: 3799-3814 (July 1, 1963).

The vertical equilibrium distributions of Rn^{222}, Rn^{220}, and their decay products in a horizontally isotropic atmosphere are calculated from diffusion theory with the help of a digital computer. The change of the turbulent diffusion coefficient with altitude and the removal of Pb^{210} and Po^{210} by fallout were taken into account. Vertical profiles of the natural radionuclides in the atmosphere are presented for several typical profiles of the turbulent diffusion coefficient. Agreement with available experimental data is rather good. The results indicate the importance of the natural radioactive tracers in the study of mixing processes in the troposphere and in the mechanism of transport from the troposphere into the lower stratosphere. (auth)

30701 ARTIFICIALLY PRODUCED RADIOACTIVE NOBLE GASES IN THE ATMOSPHERE. D. Ehhalt, K. O. Muennich, W. Roether, J. Schoelch, and W. Stich (Universität, Heidelberg). J. Geophys. Res., 68: 3817-21 (July 1, 1963).

Measurements of Kr^{85} activity in tropospheric air revealed a substantial increase in the last few years. Calculations showed that the increase could not be accounted for solely on the basis of Kr^{85} generation in bomb tests, although the activity did show increases coinciding with the tests. Results indicate that the Kr^{85} is mainly a nuclear industry product. Xe^{133} activity observed was attributed to bomb tests. Calculations on C^{14} and Ar^{37} production in bombs and measurements indicate that the bombs exploded in 1961 were unusually clean. (D.C.W.)

30702 STUDY OF ATMOSPHERIC WASHOUT PROCESSES BY MEANS OF RADON DECAY PRODUCTS. N. Bhandari and Rama (Tata Inst. of Fundamental Research, Bombay). J. Geophys. Res., 68: 3823-6(July 1, 1963).

A measurement of the departure from radioactive equilibrium between Po^{218}, Pb^{214}, and Bi^{214} in a rain cloud or in fresh rain water can provide an insight into the washout process occurring in the cloud. A convenient and easy method for estimating this departure was developed. The method consists in measuring the rate of change of the resultant activity of Bi^{214} in the rain sample as a function of time without separating the parent nuclides Po^{218} and Pb^{214}. Several rain samples collected at Bombay were analyzed using this method. The results give upper limits for the rate of removal of activity from an air mass by condensation processes on the basis of the simplified continuous washout model discussed. (auth)

30703 BERYLLIUM 7 IN THE ATMOSPHERE. G. Schumann and M. Stoeppler (Universität, Heidelberg). J. Geophys. Res., 68: 3827-30(July 1, 1963).

Measurements of Be^7 in ground-level air and rain at Heidelberg are reported. They show a close correlation to Sr^{90} data including a similar seasonal variation. This indicates a contribution from the stratosphere in these

latitudes. The annual deposition during 1960–1961 was 8.3×10^5 Be^7 atoms/cm^2. (auth)

30704 BERYLLIUM 7 IN AIR AND RAIN. D. H. Peirson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Geophys. Res., 68: 3831-2(July 1, 1963).

The Be^7 content of air near ground level and at 30,000 to 47,000 ft, as well as in rain water, was measured during 1959–1961 in the United Kingdom. A seasonal variation in the Be^7 content of air at ground level, at 4000 ft, and in rain water was observed. The variation is similar to variations noted for long-lived fission products. The maximum shifted from March in 1960 to May in 1961. (D.C.W.)

30705 REMARK ABOUT THE MEASUREMENT OF BERYLLIUM 7. K. Baumgaertel and W. Kolb (Physikalisch-Technische Bundesanstalt, Brunswick). J. Geophys. Res., 68: 3833-4(July 1, 1963).

A method for determining the Be^7 content of air or rain water by subtracting electronically the single components of a γ spectrum from a complex spectrum is illustrated. No sample has to be prepared for chemical treatment, and the amounts of other isotopes can also be evaluated. (D.C.W.)

30706 MOVEMENT OF MATERIAL FROM HIGH ALTITUDE DEDUCED FROM TRACER OBSERVATIONS. M. I. Kalkstein (Air Force Cambridge Research Lab., Bedford, Mass.). J. Geophys. Res., 68: 3835-9(July 1, 1963).

Rh^{102} and Cd^{109} were used as high-altitude tracers. Rh^{102} was injected in an air burst at about 43 km above Johnston Island on August 11, 1958. Concentrations at about 20 km showed a large increase in the late fall and winter of 1959 in the northern hemisphere. Tropospheric air concentrations at about 5 km did not reflect this increase until the spring of 1961. The Cd^{109} tracer was injected at 400 km on July 9, 1962, and is expected to appear at sampling altitudes in the fall of 1963. (auth)

30707 THE STUDY OF THE FORMATION OF A HAILSTONE BY MEANS OF ISOTOPIC ANALYSIS. L. Facy, L. Merlivat, G. Nief, and E. Roth (Meteorological Office, Paris and CEN, Saclay, France). J. Geophys. Res., 68: 3841-8(July 1, 1963).

The deuterium-hydrogen ratio of the water at various levels in a cloud can be computed from the pressure, the temperature, and the mean D/H ratio of the cloud, assuming that the condensed phase is in equilibrium with the vapor phase. A hailstone was collected, and the D/H ratio of the successive layers was determined. From these values and the knowledge of the vertical structure of the atmosphere during the shower, the life history of the hailstone can be traced. The results of the isotopic analysis were also compared with the photographic analysis of other hailstones collected from the same shower. A further exploration of the isotopic technique for the investigation of hail may lead to other important conclusions. (auth)

30708 STUDIES OF GLOBAL EXCHANGE PROCESSES IN THE ATMOSPHERE BY NATURAL AND ARTIFICIAL TRACERS. C. E. Junge (Universität, Mainz). J. Geophys. Res., 68: 3849-56(July 1, 1963).

An analysis of data on tropospheric concentrations of fission products (Be^7, C^{14}, and O_3) results in a quantitative expression for the seasonal variation of the injection rate of stratospheric constituents into the troposphere, which can be applied for all constituents of a similar distribution within the stratosphere. The analysis is based on the fact that the seasonal variation of the tropospheric concentration can be approximated by a simple sine function and on the assumptions that the removal of the constituent from the troposphere is a first-order process and that the troposphere is a well-mixed reservoir. The differences in amplitude and phase of the various constituents can be explained by this model. A similar study was made for the exchange rate between the northern and southern hemispheres. Data on carbon dioxide and tritiated methane indicate that the exchange rate is rather small, i.e., of the order of 0.5/year, whereas the exchange rate within the hemispheres appears to be considerably larger. These values are in agreement with previous estimates by other authors on the basis of C^{14} data. (auth)

30709 THE INFLUENCE OF THE WEATHER ON THE CONCENTRATION OF NUCLEAR BOMB DEBRIS IN AIR. Per B. Storeboe (Norwegian Defense Research Establishment, Kjeller, Norway). J. Geophys. Res., 68: 3857-9 (July 1, 1963).

Daily measurements of the concentration of nuclear bomb debris in air in terms of gross β radioactivity were made by the Norwegian Defense Research Establishment at a number of places in Norway. The weather developments were examined for samples collected during the period July 1, 1957, to June 30, 1959. It was found that low radioactivity was predominantly associated with centers of low pressure, with influx of arctic air, or with rainy weather. High radioactivity was predominantly associated with centers of high pressure, with influx of warm subtropical air, or with marked frontal passages. This indicates that concentrations of nuclear bomb debris become adjusted to weather conditions fairly rapidly. The statistics seem to be satisfactorily explained if the principal removal agent is precipitation and the principal ways of replenishment are vertical downward transport in high-pressure centers and overturning of air in frontal zones. The low concentration in arctic air may well be due to a short residence time of air in the Arctic. It need not reflect a lack of downward flux in this area. (auth)

30710 ATMOSPHERIC CIRCULATION FROM OBSERVATIONS OF NATURAL RADIOACTIVITY. Rama (Tata Inst. of Fundamental Research, Bombay). J. Geophys. Res., 68: 3861-6(July 1, 1963).

The results of measurements of the cosmic-ray-produced isotopes P^{32}, P^{33}, Be^7, S^{35}, and Na^{22} in wet precipitations and in the tropospheric and stratospheric air are discussed in relation to the time scales of the dominant exchange and mixing processes operative in the atmosphere. (auth)

30711 INVESTIGATION OF RADON DAUGHTERS. G. Schumann (Universität, Heidelberg). J. Geophys. Res., 68: 3867-9(July 1, 1963).

A Goetz aerosol spectrometer and low-level counting techniques were used in studying the size distribution of natural radioactive aerosol particles. A number of values down to radii of 3×10^{-6} cm were obtained. These are compared with computed distribution curves and with estimates from experimental work of a different kind. (auth)

30712 POSSIBLE FLUCTUATIONS IN ATMOSPHERIC CARBON DIOXIDE DUE TO CHANGES IN THE PROPERTIES OF THE SEA. Erik Eriksson (International Atomic Energy Agency, Vienna). J. Geophys. Res., 68: 3871-6 (July 1, 1963).

The effect of variation of the properties of the sea on the atmospheric CO_2 concentration is investigated by using the equilibrium equations of the CO_2 system in sea water in their variational form. The general conclusion from this study is that neither temperature nor volume changes of the sea can have been large enough to cause any appreciable change in the atmospheric CO_2 concentration, at least not

of any climatic importance. It is, however, pointed out that there is a considerable excess of CO_2 in the ocean, owing to a combination of biological and gravitational processes, which, if released, would increase the atmospheric concentration by a factor of 5. Serious disturbances in the biological circulation of carbon in the sea in the past may have caused wide fluctuations in the atmospheric CO_2, and some possible causes for such disturbances are discussed briefly. (auth)

30713 ON THE INFLUENCE OF CHANGES IN THE CO_2 CONCENTRATION IN AIR ON THE RADIATION BALANCE OF THE EARTH'S SURFACE AND ON THE CLIMATE. F. Moeller (Universität, Munich). J. Geophys. Res., 68: 3877-86(July 1, 1963).

The numerical value of a temperature change under the influence of a CO_2 change as calculated by Plass is valid only for a dry atmosphere. Overlapping of the absorption bands of CO_2 and H_2O in the range around 15 μ essentially diminishes the temperature changes. New calculations give $\Delta T = +1.5°$ when the CO_2 content increases from 300 to 600 ppm. Cloudiness diminishes the radiation effects but not the temperature changes because under cloudy skies larger temperature changes are needed in order to compensate for an equal change in the downward long-wave radiation. The increase in the water vapor content of the atmosphere with rising temperature causes a self-amplification effect that results in almost arbitrary temperature changes, e.g., for constant relative humidity $\Delta T = +10°$ in the above-mentioned case. It is shown, however, that the changed radiation conditions are not necessarily compensated for by a temperature change. The effect of an increase in CO_2 from 300 to 330 ppm can be compensated for completely by a change in the water vapor content of 3 per cent or by a change in the cloudiness of 1 per cent of its value without the occurrence of temperature changes at all. Thus the theory that climatic variations are effected by variations in the CO_2 content becomes very questionable. (auth)

30714 UPPER TROPOSPHERIC CARBON 14 LEVELS DURING SPRING 1962. G. J. Fergusson (Univ. of California, Los Angeles). J. Geophys. Res., 68: 3933-41 (July 1, 1963).

Measurements of the C^{14} activity of atmospheric CO_2 at an altitude of 12 km and at latitude 35°N showed wide variations during the spring of 1962 due to the transfer of $C^{14}O_2$ from the stratosphere to the upper troposphere. A series of peaks of activity were observed, the activity ranging from ground-level value up to four times the normal value. A high-altitude sampler with molecular sieves and a capacity of up to 20 liters of CO_2 in 2 hrs was used. The observed increase of C^{14} activity from January to July 1962 was 14%. (auth)

30715 ATMOSPHERIC IODINE, BROMINE, AND CHLORINE. Robert A. Duce, John T. Wasson, John W. Winchester, and Forrest Burns (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 68: 3943-7(July 1, 1963).

Iodine, bromine, and chlorine were determined by means of neutron activation analysis in a series of aerosols and rain-water samples collected in Hawaii. Five-milliliter samples of rain water are used in the analytical procedure, and no chemical treatment is required before pile irradiation. Freedom from errors due to contamination and species-specific chemical steps is thus assured. The ratio I/Cl in the aerosols and rain water is more than 100 times greater than published values for sea water, but the ratio Br/Cl is the same as that for sea water within a factor of 2. The seven samples of rain water, collected in October and November 1961, and the eight samples of aerosols, collected from a light aircraft in May 1962, show that I/Cl is greater in rain by a factor of 3, that Br/Cl is greater in rain by a factor of 2, and that I/Br is greater in rain by a factor of 1.5. (auth)

30716 THE GENERAL CIRCULATION OF THE ATMOSPHERE AND ITS EFFECTS ON THE MOVEMENT OF TRACE SUBSTANCES. Reginald E. Newell (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 68: 3949-62(July 1, 1963).

A brief summary is made of present knowledge of horizontal and vertical motions in the atmosphere with particular reference to large-scale motions which may be expected to redistribute trace substances over long time periods. Mean motions, standing eddy motions, and transient eddy motions are defined and discussed separately, variance data being used as a measure of the transport properties of the eddies. Hemispheric data concerning both horizontal and vertical components are available up to about 25 km, and there are limited samples of horizontal component data up to 60 km. Indications are that eddy motions, rather than mean motions, are the main transport process up to 25 km. Variance data show maximums in both horizontal and vertical components in the vicinity of the tropospheric jet stream and in the vicinity of the polar night stratospheric jet. In the troposphere the smallest values of both horizontal and vertical variances occur in the low latitudes of the tropics. The data are applied to a discussion of the distribution of long-lived fission products in the atmosphere. A possible explanation for the inclination of the concentration isolines of the trace substances to the isentropic surfaces is presented. Finally, the general approach is applied to the particular case of the budget of ozone in the stratosphere. (auth)

30717 VLF DISTURBANCES CAUSED BY THE NUCLEAR DETONATION OF OCTOBER 26, 1962. A. J. Zmuda, B. W. Shaw, and C. R. Haave (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 68: 4105-14(July 1, 1963).

At 1000 UT on October 26, 1962, a submegaton nuclear bomb was detonated at an altitude of tens of kilometers in the vicinity of Johnston Island. The burst produced phase perturbations of the stabilized 19.8-kc/s transmission from station NPM in Hawaii as received in Anchorage, Alaska, and the Applied Physics Laboratory of the Johns Hopkins University. The VLF perturbations may be separated into: an instantaneous disturbance caused by charged particles immediately deflected from the burst region into the VLF transmission path; a delayed perturbation starting at 2 minutes after the burst with a peak at 4 minutes, and having a general temporal variation indicating that this phase variation is due to geomagnetically trapped β rays from the radioactive decay of neutrons. (auth)

30718 AN ANALYSIS OF THE RADIOACTIVE FALLOUT OVER NORTH AMERICA IN LATE SEPTEMBER 1961. Samuel Penn (Air Force Cambridge Research Labs., Bedford, Mass.) and E. A. Martell. J. Geophys. Res., 68: 4195-4207(July 15, 1963).

Unusually intense radioactive fallout of short-lived fission products was experienced in widespread areas of the United States and Canada during the period September 16 through 22, 1961. The available evidence indicates two radioactive fallout sources in the troposphere: a concentrated debris layer of Soviet test origin observed over Flin Flon, Manitoba, Canada, on September 14–15 and a

radioactive cloud source from the vented Nevada underground shot of September 15. The convergence of atmospheric trajectories for these two sources on September 17 and 18 limits the discrimination of the fallout origin at some locations. However, the intense fallout over southeastern and central United States on September 18 and thereafter conforms to the pattern and timing for the September 15 Nevada cloud source trajectories. (auth)

30719 RARE-EARTH DISTRIBUTIONS IN THE MARINE ENVIRONMENT. Edward D. Goldberg (Univ. of California, San Diego), Minoru Koide, R. A. Schmitt, and R. H. Smith. J. Geophys. Res., 68: 4209-17(July 15, 1963).

Analyses for the rare-earth elements in sea water, in a phosphorite, and in a manganese nodule were made by neutron activation and x-ray fluorescence techniques. These marine samples showed a depletion in the heavier rare-earth elements, relative to chondritic meteorites, beginning with samarium. Cerium was enriched in the manganese nodule, probably as a result of its oxidation to the 4+ valence state. The ratios of the rare-earth abundances in the two minerals to those of sea water go through a maximum in the vicinity of samarium. The europium concentration, often anomalous in terrestrial minerals, was normal relative to the other rare earths in all of the samples. The sea water showed four times the concentration of rare earths at a depth of 4000 meters as compared with surface values. (auth)

30720 ISOTOPIC COMPOSITION OF GERMANIUM IN METEORITES. Masako Shima (Univ. of California, San Diego). J. Geophys. Res., 68: 4289-92(July 15, 1963).

The isotopic composition of germanium in eight meteorites was measured by solid-source mass spectrometer and compared with a sample of terrestrial origin. No difference in the isotopic composition of germanium from meteorites and the terrestrial sample was found outside of the error. (auth)

30721 AGE ESTIMATION OF OCEAN SEDIMENTS BY IONIUM-PROTACTINIUM METHOD. I. E. Starik, A. N. Elizarova, and Yu. V. Kuznetsov. Radiokhimiya, 5: 154-7(1963). (In Russian)

A method was developed for separation of Pa from large (20 to 30 g) specimens of ocean sediments with simultaneous determination of thorium. Radiochemical analysis of ocean sediments showed that the Io/Pa^{231} ratio can be used for dating sediment layers in the ocean. The results are in agreement with the results obtained with radiocarbon. (R.V.J.)

30722 ISOTOPIC CONTENT OF LEAD IN ANCIENT ROCKS. E. V. Sobotovich, S. M. Grashchenko, and A. V. Lovtsyus. Radiokhimiya, 5: 157-60(1963). (In Russian)

The feasibility of dating ancient oxides and basic rocks by the ratio Pb^{207}/Pb^{204}, Pb^{206}/Pb^{204} was verified. The age of the migmatites in the pre-Dnepr region was established as 2950 ± 150 million years. The result is based on the analysis of 21 specimens of rocks and rock-forming minerals. (R.V.J.)

30723 ISOTOPIC CONTENT OF NORTH TYAN SHAN LEAD DEPOSITS. L. Ya. Atrashenok, P. V. Atrashenok, G. V. Avdzeiko, A. Ya. Krylov, and A. V. Lovtsyus. Radiokhimiya, 5: 160-4(1963). (In Russian)

Isotopic composition of Northern Tyan Shan lead deposits was determined. Most of the Tyan Shan galena outcrops had identical isotopic composition indicating similarity of origin. (R.V.J.)

30724 ON RADIOACTIVE EQUILIBRIUM IN EAST ANTARCTIC ROCKS. L. Ya. Atrashenok and A. Ya. Krylov. Radiokhimiya, 5: 170-2(1963). (In Russian)

A radioactive equilibrium was observed in East Antarctic granite rocks. In some gneiss and sandstones the balance was disturbed by radium enrichment. A radiochemical determination (uranium–radium ratio) was possible for the igneous rocks while sedimentary and metamorphous rocks demanded a direct determination of uranium. (R.V.J.)

30725 EVOLUTION OF RADIOACTIVITY AND GENERAL CHEMICAL COMPOSITION OF NORTH TYAN SHAN ROCKS. A. Ya. Krylov. Radiokhimiya, 5: 173-82(1963). (In Russian)

Geochemical studies were made of radioactive rocks in the Northern Tyan Shan region and geological history was traced through various age granite intrusions. Evolutionary processes in earth's crust were also studied as to variations in radioactive and basic rock forming elements. A certain enrichment in rock of radioactive elements was noted. (R.V.J.)

30726 SEPARATION OF RADIOACTIVE CESIUM FROM SEA WATER. II. SEPARATION OF Cs WITH ALKALI FERROCYANIDES. L. M. Ivanova and V. P. Shvedov. Radiokhimiya, 5: 185-9(1963). (In Russian)

A complete separation of Cs^{137} from sea water was achieved by coagulation of precipitates and by separation from the solution by precipitation on nickel and copper ferrocyanide. The presence of sea salts in the solution does not affect the Cs^{137} capture by ferrocyanides. (R.V.J.)

30727 THE LITHOLOGICAL SERIES AND THE URANIFEROUS BEDS OF COLLE CIARBONET (ALPI COZIE). Eleonora Zanettin (CNRN, Rome). Studi Ric. Div. Geomineraria, Comit. Nazl. Ric. Nucl., 3: 219-56(1960). (RT/GEO(63)16). (In Italian)

Geological remarks on the axial zone of the Cottian Alps are given, along with a description of the Permotriassic lithological series that outcrops at the Colle Ciarbonet and in which some uraniferous beds exist. The Permian schistes derive from slightly metamorphosed sediments, which were formed by the material resulting from the decay of porphyric rocks and of schistes. It was concluded that the Permian sediments have been laid down in shallow sea water; the uranium would have been adsorbed by colloidal ferric hydroxides. (auth)

30728 THE HYDROGEOCHEMICAL PROSPECTION OF URANIUM. M. Dall'aglio (CNRN, Rome) and F. Tonani. Studi Ric. Div. Geomineraria, Comit. Nazl. Ric. Nucl., 3: 354-86(1960). (RT/GEO(63)20). (In Italian)

The geochemical mobility of uranium in the normal conditions of pH, oxidation-reduction, salinity and uranium content of vadose waters is of the same order as the calcium and sodium mobility. A strongly anomalous uranium content is geochemically stable. Therefore, the hydrography is the fundamental factor determining the shape of the halos of hydrogeochemical surface dispersion of uranium. The processes of mutual dilution and mixing of surface waters depend on hydrography. The known phenomena, that can lessen the mobility of uranium, are realized in the ground water environment, and the border of surface oxidizing environment. The phenomena do not affect the operational criteria of the strategic hydrogeochemical prospecting in surface waters, but they are important in determining the underground regions escaping hydrogeochemical strategic exploration. The writers describe the employed apparatus and methods of uranium determination by fluorimetric methods. (auth)

30729 WATER CONTENT MEASUREMENT BY NEUTRON ATTENUATION AND APPLICATIONS TO UNSATU-

RATED FLOW OF WATER IN SOIL. Gordon Le Roy Stewart. Thesis, Seattle, Washington State Univ., 1962. 107p.

Adequate testing of the applicability of diffusional type equations to studies of unsaturated water flow requires a precise method for water content measurement. A neutron-matter interaction technique has been developed in this investigation to measure water contents of small volume elements of soil accurately, rapidly and at frequent time intervals. This method can be used to measure water content in many types of experiments but it is particularly well suited for experiments involving transient flow. High thermal neutron fluxes, available only from nuclear reactors, are required. The method measures, nondestructively, water content as a function of time and position. Precisions for 2 sec counting and a resolution of 1 mm by 1 cm for dry and wet water content regions (about 5% and 25% water) are about ±0.2% and ±0.8% water. At 20 seconds counting time the precisions expected are about ±0.07% and ±0.2% water. Neutron attenuation is not seriously affected by density changes but soil bulk density can be measured by use of long counting times. Precision for soil bulk density measurement is about ±0.004 gm/cm^3 with counting times of about 200 sec. With the fluxes available at the Washington State University reactor it appears possible to improve the present resolution by a factor of 10 beyond that reported here. Experiments were designed for use of this technique to study the effect of temperature and the effect of initial water content of a porous medium on flow. The relationship between the locus of a point at constant water content, X_θ, and time was used to test the appropriateness of the Boltzmann transformation under these experimental conditions. The results show that X_θ and $\sqrt{t}$ generally are not linearly related. However, for columns containing initially greater water contents there appears to be a near-linear relationship between X_θ and $\sqrt{t}$. This suggests that the assumptions required for the use of the Boltzmann transformation are more closely met under conditions where heat of wetting is reduced. Diffusivities, $D(\theta)_t$, were calculated both with and without use of the Boltzmann transformation. A comparison of calculated values of $D(\theta)_t$ indicates that use of the Boltzmann transformation to calculate $D(\theta)_t$ may be appropriate for practical work where great precision is not required. The results suggest that at high water contents the diffusivity is not a unique function of water content but that it may be a function of time or a variable dependent upon time as well. At low water contents and long infiltration times $D(\theta)_t$ appears to be independent of time. At high water contents the effect of temperature on $D(\theta)_t$ appears to be primarily due to a change in viscosity with temperature. As water content decreases diffusivity becomes practically independent of temperature because the effect of temperature on the sorption term, $\partial\Psi/\partial\theta$, becomes increasingly important, compensating for the opposite effect on viscosity. (Dissertation Abstr., XXIII, No. 12(I))

30730 RADIOACTIVE DATING. Proceedings of the Symposium Held in Athens, 19-23 November 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. April 1963. 443p. (STI/PUB/68). $8.50; 178.50s; NF 34; DM 29.80(IAEA)

A total of 31 papers is presented on the methods and applications of radioactive dating. The papers are arranged in four sections dealing with new methods and possibilities, applications in geochemistry and geophysics, applications in geology, and applications to meteorites. Separate abstracts were prepared for 17 of the papers; 11 of the remaining papers had previously been abstracted in NSA. (D.L.C.)

30731 THE HALF-LIFE OF C^{14} AND THE PROBLEMS WHICH ARE ENCOUNTERED IN ABSOLUTE MEASUREMENTS ON β-DECAYING GASES. Ingrid U. Olsson and I. Karlén (Uppsala Univ.). p.3-11 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

New determinations of the half life of radiocarbon have been performed at National Bureau of Standards, Washington, D. C., USA; at Atomic Weapons Research Establishment, Aldermaston, England, and at the Institute of Physics, University of Uppsala, Sweden. The results are given as 5760 ± 50, 5780 ± 65, and 5685 ± 35 years respectively. The old accepted value was 5568 ± 30 years. In the Uppsala determination, a proportional counter, having an inner dia of 66 mm was used. It was equipped with a screw making it possible to move one end, thus allowing the counter to take any sensitive length between 12 and 25 cm, so that the end effects could be eliminated. The active sample was CO_2 liberated from $BaCO_3$ by thermal action. The sample was carefully diluted 10^9 times with pure, inactive CO_2, and the diluted gas used as counting gas. In one case acetylene was used as counting gas. The wall effect was eliminated by using 1.5 to 4 atm pressure. Special precautions had to be taken to eliminate errors due to adsorption. The determination resulted in the value 5685 ± 35 years for the half life of C^{14}, where the indicated uncertainty denotes an estimated probable error of the result. (auth)

30732 LOW-LEVEL COUNTING METHODS. H. Oeschger (Universität, Bern). p.13-34 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

A review of naturally occurring radioisotopes, which are of interest for radioactive dating and the physical properties of their decay, is given. The problem of measuring these isotopes is discussed and several special types of low-level counting devices are required (e.g., counters for low specific β activity of high or low energy, counters for low absolute β activity of high or low energy; coincidence counters for the measurement of low specific positron activity, etc.). Attention is drawn to the principal properties of radiation detectors (mainly gas counters and scintillation counters) used for low-level investigations. The common methods of background suppression are described. Experiments involving the analysis of the residual background of low-level gas counters are described. By these investigations several components can be distinguished and the possibilities of their further reduction are discussed. A general formula for the prediction of the background of counters of arbitrary design is deduced. The knowledge about background from gas counters is applied to scintillation counters taking into consideration their special properties. A review of the various types of counters used for the different problems of low-level measurements mentioned above is given. By making use of the present experiences with high sensitivity counting, the qualifications of the different instruments are compared. The necessity for a further increase of sensitivity in low-level counting and the possibilities for obtaining this increase are discussed. (auth)

30733 AGE DETERMINATIONS BY THE RHENIUM–OSMIUM METHOD. B. Hirt (Universität, Bern), W. Herr, and W. Hoffmeister. p.35-43 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

The β decay of Re^{187} to Os^{187} was used for age determinations for iron meteorites and for terrestrial molybdenite samples. For the meteorite samples the content of rhenium and of common osmium was measured by neutron-activation analysis. The enrichment of radiogenic Os^{187} was measured by a mass spectrometer. In terrestrial molybdenite samples, practically no common osmium could be found. The rhenium content was measured by neutron activation, the Os^{187} content by isotopic dilution using common terrestrial osmium as a "spike." A number of molybdenites of known age (cogenetic minerals dated by other radioactive methods) were analyzed to evaluate more exactly the half life of Re^{187}. (auth)

30734 INVESTIGATIONS OF THE HELIUM AGE DATING METHOD BY STABLE ISOTOPE-DILUTION TECHNIQUE. P. E. Damon and W. D. Green (Univ. of Arizona, Tucson). p.55-71 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

An investigation was carried out on the helium age dating method which previously had not produced consistently correct ages. In the earlier investigations helium was determined volumetrically, whereas in the work reported here, helium is determined by a stable isotope-dilution technique using He^3 as the isotopic diluent. Both a dynamically operated Nier 6-in., 60°-sector field mass spectrometer and a statically operated trochoidal mass spectrometer were used for determining the He^4/He^3 isotope ratio of the spiked sample. With the statically operated instrument, a signal of one millivolt is obtained upon the introduction of 3×10^{-12} mole of helium, whereas the noise level is only ±0.04 mv. The isotope-dilution technique is both more sensitive and more accurate than volumetric measurements of small quantities of helium. There are a number of problems inherent in the helium age method: (1) the helium nuclei, which are ejected from radioactive elements with high energies and correspondingly high velocities, travel a finite distance before coming to rest and consequently may be lost to grain boundaries; (2) the high energies involved in alpha decay sometimes result in radiation damage (metamictization) which can result in loss of helium through a permeable glass phase; (3) helium may be lost from the radioactive mineral due to thermal diffusion at elevated temperatures; (4) helium may be occluded in structural channels within certain minerals, e.g., beryl and cordierite or possibly within cation and anion vacancies; (5) anomalous uranium and thorium concentrations due to surface coatings may occur in minerals within which uranium and thorium are nonessential trace constituents. In spite of these problems, the sensitivity of the helium method, the presence of measurable quantities of uranium, thorium, and helium in a wide variety of minerals, and the relative freedom from errors due to atmospheric contamination warrant further investigation of this method. So far, two minerals were re-investigated which show promise as geologic chronometers: (1) zircon in which uranium and thorium are present at acceptable substitutions for zircon, and (2) magnetite in which the presence of uranium and thorium involves substitutional disorder. The helium method yields results for zircon which compare favorably with the potassium-argon method with the exception of minerals which have suffered metamictization. Results for magnetite are complicated by the frequent occurrence of uranium and thorium as superficial coating on grain boundaries. Diffusion experiments indicate that at 1150°C, slightly over 60 ppm of uranium and at least 760 ppm of thorium can be accommodated within defect structures in magnetite. Upon cooling, uranium and thorium diffuse toward grain boundaries providing one mechanism for the occurrence of grain boundary contamination. In order to date magnetite, it is first necessary to remove the superficial coating. Accurate results can only be obtained for magnetite grains containing disseminated, non-superficial uranium and thorium where the grain size is large compared with the range of alpha particles in magnetite. (auth)

30735 NEW DEVELOPMENTS IN THE THERMOLUMINESCENCE METHOD OF GEOLOGIC AGE DETERMINATION. E. J. Zeller and L. B. Ronca (Univ. of Kansas, Lawrence). p.73-85 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

In the light of past difficulties with this age determination method, an intensive investigation was undertaken to determine possible causes of the frequently erroneous results. The effects of temperatures below 80°C were found to be geologically insignificant for the 315°C glow-curve peak in limestone. On the other hand, time-temperature relationships were developed for the 228°C glow-curve peak thus providing a potential source of paleoclimatological data. In the past, samples were thermally drained before being exposed to radiation in order to determine their calibration curve. It was found that this practice can result in appreciable decrease in luminous efficiency. However, ultraviolet radiation can be used to drain the natural thermoluminescence to less than 3% of the original value, thus allowing the determination of the calibration curve without attendant thermal effects. It should be noted, however, that care must be taken to avoid unintentional exposure of the sample, especially in powdered form, to any light source having a significant ultraviolet component. Workers in thermoluminescence have generally been aware that inconsistent results were obtained if glow curves were run too soon after irradiation. A systematic study of the phenomenon shows that, after irradiation changes in peak height, as great as 15% of the average value can be found. Peak areas are similarly effected. This shift was found to continue longer than 40 hr after irradiation. The calibration curve can be plotted using the extrapolated zero time or the average value. Studies are in progress to determine which method is the closest approximation to the natural process. Frequently, age calculations have failed to include the effects of natural radiation in electron trap production. Experimental results show that trap production is essentially a linear process for radiation dosages of the levels expected in natural limestones. This fact may account for the tendency of relatively highly radioactive samples to appear too young and conversely samples of low radioactivity appear too old. Finally, grinding effects must be taken into consideration. It is shown that grinding affects a peak at about 370°C. This peak may overlap the 315°C glow-curve peak which is generally used for age determination. Careful selection of grain size permits good resolution. None of the newly discovered factors has brought the basic theory of the thermoluminescence method of geologic-age determination into question. It is clear, however, that the relatively simple methods by which the first determinations were made could have introduced extremely large errors. (auth)

30736 GEOCHRONOLOGY WITH LEAD-210. Edward D. Goldberg (Univ. of California, La Jolla). p.121-31 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

The distribution of lead-210 in various members of the

terrestrial hydrosphere is of particular interest with respect to the measurement of time in geochemical processes which have taken place within the last one hundred years or so. This isotope is brought into the major sedimentary cycle in the following way. The rare gas isotope radon-222, a precursor of lead-210 in the uranium-238 series, escapes from surface rocks into the atmosphere where it decays with its half life of 3.8 days. Following a series, of short-lived daughters, lead-210, whose half life is 21.4 yr, is formed. The lead-210 is removed from the troposphere either to the stratosphere by atmospheric mixing processes or to the earth's surfaces by precipitation. The residence time for lead-210 in the atmosphere is of the order of several weeks. Since lead-210 is free of its parents in rains and snow, this isotope provides a convenient time clock for chemical and physical reactions in natural waters. Techniques for the assay of lead-210 in natural waters are described using low-level beta counting techniques and simplified chemistries for the isolation of lead, both of which were developed in our laboratories. These methods were applied to numerous sea water, river, and glacier samples. The distributions of lead-210 in the Colorado and Sacramento Rivers indicate a rapid removal (times of the order of weeks) along their paths from the feed-water origins to the outfalls. The results clearly direct one to the conclusion that composition of river waters reflects not only the geology of the drainage basin and the accompanying weathering processes therein but also, and possibly of equal significance, the chemical reactions, either inorganic or biochemical, that occur within these waters. The dissemination of the isotope in oceanic waters suggests a very short residence time in the upper mixed layers and a transfer to deeper waters by chemical processes. Residence times in the upper mixed layer of about 5 years are derived. It is suggested that the marine biosphere is responsible for the conveyance of lead from surface to deeper waters. Studies on the distribution of the isotope in glaciers have been initiated with two questions in mind: can this isotope be used to establish a geochronology in the formation of ice-sheets; and can the surface lead-210 concentrations in glaciers as a function of geographical location be used to study the atmospheric behavior of this isotope? A positive answer to the first query was found in studies on Greenland glaciers where rates of accumulation based on the decay of lead-210 were in complete agreement with those based on stratigraphic evidence. At present experimental data on the second question are too limited for any conclusions. (auth)

30737 RADIOACTIVE DISEQUILIBRIUM AND ISOTOPES OF THORIUM IN GEOCHRONOLOGY. C. Coquema, R. Coulomb, M. Goldsztein, and J. C. Schiltz (CEN, Fontenay-Aux-Roses, France). p.133-48 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In French)

Systematic work was going on for a number of years to determine the main natural radionuclides (U^{238}, Ra^{226}, Th^{230}, Pa^{231}, Rn^{222}, Po^{210}, and Th^{232}) present in a wide variety of geological materials (rocks, soils, ores, river, and marine sediments) with a view to working out the pattern of radioactive equilibrium and the laws of geochemical distribution. Although the primary objective of this work is to obtain precise data on weathering or deposit phenomena, the results which were obtained can be applied directly to geochronological problems. The radiochemical and radiometrical methods which are used routinely are described. These involve the use of multichannel alpha and gamma spectrometers, alpha and beta counting with automatic low-background sets, and the determination of radon by scintillation balloons and of uranium by fluorimetry. Some typical results are given for various geochemical models; on this basis it is possible to make age determinations of secondary mineralization in deposits or to calculate sedimentary deposit rates. Emphasis is laid on the need for subjecting both the sample and the environment to a simultaneous and thorough geochemical study. (auth)

30738 STUDY OF LONG AND SHORT-TERM GEOPHYSICAL PROCESSES USING NATURAL RADIOACTIVITY. D. Lal (Tata Inst. of Fundamental Research, Bombay). p.149-57 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

Radioisotopes of widely different half lives are being injected continuously in the atmosphere as a result of nuclear interactions of cosmic-ray particles with the atmospheric nuclei. The rates of introduction vary appreciably with latitude and altitude, but are essentially constant with time and are measurable with a fair degree of accuracy. The large-scale atmospheric circulation and the scavenging processes operative in the lower troposphere remove these isotopes effectively from the atmosphere. These isotopes then partake in the mixing cycles operative for matter in the uppermost layers of the lithosphere, and in the biosphere and the hydrosphere. The resulting steady-state distribution of the various isotopes on the earth, arising from such a continuous and constant injection in the atmosphere, is indicative of the nature and details of a large number of intricate geophysical and geochemical processes. A review is presented of the applications of the cosmic-ray produced isotopes as tracers for studying particular problems in earth sciences, such as large-scale atmospheric circulation, water circulation in the oceans, and for dating the ocean sediments. Also some of the possibilities are given for using the cosmic-ray produced isotopes of atmospheric and non-atmospheric origin for certain geophysical investigations. (auth)

30739 INVESTIGATIONS IN MARINE ENVIRONMENTS USING RADIOISOTOPES PRODUCED BY COSMIC RAYS. D. P. Kharkar, D. Lal, and B. L. K. Somayajulu (Tata Inst. of Fundamental Research, Bombay). p.175-87 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

The results of determination of the concentrations of Be^{10} in deep sea sediment cores raised from the Pacific are presented. These results are discussed in relation to the rates of sedimentation and of the influx of extraterrestrial dust during the last few million years. Attempts were made to study the short-term chronologies in biogenous silica-rich sediments raised from the Pacific ocean. The specific activity of Si^{32} was measured in surface waters of the Pacific, Atlantic, Indian, and Antarctic oceans. The implications of the observed distribution to the gross features in the large-scale oceanic circulation are discussed. (auth)

30740 INVESTIGATION OF MERIDIONAL TRANSPORT IN THE TROPOSPHERE BY MEANS OF CARBON-14 MEASUREMENTS. K. O. Muennich and J. C. Vogel (Universität, Heidelberg). p.189-97 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

The seasonal varying injection of bomb carbon-14 from the stratosphere gives rise to a pile-up in higher latitudes in the northern hemisphere. This brings about seasonal variation with the maximum of the tropospheric carbon-14 level in summer. Investigation of the decay of carbon-14

concentration during autumn gives information about the meridional transport of air masses. (auth)

30741 DISCORDANCES IN K–Ar AND Rb–Sr ISOTOPIC AGES. J. L. Kulp and Joan Engels (Columbia Univ., Palisades, N. Y.). p.219-38 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

The isotopic ages from the K–Ar and Rb–Sr methods can be concordant where ideal mineral histories occur. The common discordances depend on a variety of effects but the most important factors are temperature and base exchange. Local heating such as the intrusion of a Tertiary dike into an old metamorphic complex will lower the K–Ar age of biotite at much greater distance than hornblende. In the case of regional heating the K–Ar age on both minerals may be lowered together. The widths of transitional age belts in an older basement peripheral to the zone of a younger metamorphism were defined in a number of cases. The effect of local structure can also be observed. The Rb–Sr isotopic ages in feldspar are generally more resistant to temperature effects than the K–Ar isotopic ages in mica. Rb–Sr ages in biotite are commonly unreliable, apparently due to base exchange processes at surface conditions. K–Ar isotopic ages are reliable minimum ages. Examples of these different cases of discordance and new experimental work on base exchange effects on biotite are reported. The discordances provide useful information on the geochemical history of the region. (auth)

30742 THE USE OF COGENETIC URANIUM–LEAD ISOTOPE SYSTEMS IN ZIRCONS IN GEOCHRONOLOGY. Leon T. Silver (California Inst. of Tech., Pasadena). p.279-87 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

Observations of uranium concentrations in zircons in many igneous rocks indicate that generally the suite of zircons in samples as small as two kilograms is quite inhomogeneous in terms of uranium and thorium concentrations. By careful mineral separations on a single granite sample, it is possible to obtain a number of zircon fractions with significantly different U–Th–Pb isotope properties in each fraction. Analysis of suites of zircon fractions demonstrates remarkably regular isotope relations in the systems Pb^{206}/U^{238} – Pb^{207}/U^{235} for each suite. Since these various systems are clearly cogenetic and have shared a common history, it is possible to investigate in appropriate samples the influence of various mineralogical, geological, and chemical factors on the phenomena of discordance in the U–Pb systems. In particular, a significant dependence between the degree of discordance and the relative radioactivities of various zircon fractions was demonstrated. Further investigation of this relation is in progress. Employing these families of cogenetic systems, several pre-Cambrian suites in western North America have shown evidence of a relatively simple two-episode history: (1) crystallization and (2) metamorphism. These two-episode histories are compatible with carefully studied field relations. Further, it appears possible to use these families of U–Pb systems to resolve real differences in relative ages of as little as 2%. Examples involving systems of approximately 1100 Myr and 1700 Myr in age can be cited. (auth)

30743 STUDIES ON THE COSMIC-RAY PRODUCED NUCLIDES Be^{10}, Al^{26} AND Cl^{36} IN IRON METEORITES. F. Sammet and W. Herr (Universität, Cologne). p.343-54 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

A series of iron meteorites (finds and falls) were analyzed simultaneously for the long-lived radionuclides Be^{10}, Al^{26}, and Cl^{36}. Special care was taken to reduce the amounts of the carriers (all <10 mg) and on the development of the chemical separation and recycling process. As for the chlorine the distillation procedure proved to be most effective. The Al^{26} isolation was performed by diethylether extraction of iron plus beryllium. The Be^{10} was recovered from the bulk material by diisopropylether and purified as Be acetylacetonate. Preparations of BeO, AgCl, and Al_2O_3 were measured under an anti-coincidence-shielded end-window (flow) counter with isobutene-He in the Geiger region. With available Ar^{36} contents Cl^{36}-radiation ages are calculated which were (with the exception of Sikhote Alin = $(70 \pm 10)\ 10^6$ yr) all in the range of several 10^8 to 10^9 yr. The results on the Be^{10} decay rate were found to be relatively high compared to those (few) figures already given in literature. The ratio Be^{10}/Cl^{36} is between 0.7 and 0.9, consistent with constant irradiation. An exception makes Grant with the ratio 1.1. Under the assumption that this deviation is caused by the relative shorter half life of Cl^{36} compared to Be^{10}, the time of fall was calculated. In this respect also a preference of fragmentation over spallation processes may be discussed. However, the ratio Al^{26}/Cl^{36} is found to be relatively small, about 0.2, which is in agreement with the facts that the 26 mass region spallation yields approach minimum values. (auth)

30744 THE COSMIC-RAY EXPOSURE AGES OF IRON METEORITES AS DERIVED FROM THE ISOTOPIC COMPOSITION OF POTASSIUM AND THE PRODUCTION RATES OF COSMOGENIC NUCLIDES IN THE PAST. H. Voshage and H. Hintenberger (Max-Planck-Institut für Chemie, Mainz). p.367-79 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

As K^{40} is the longest-lived radioactive nucleus produced by cosmic rays in iron meteorites, determinations of cosmic-ray exposure ages by employing the potassium isotopic abundances in these meteorites, are of particular significance in the study of both meteorite and cosmic-radiation history. A discussion is presented of the determination of the potassium-isotope production ratios. Using this information and the experimental potassium-isotope abundance ratios, the exposure ages of 17 meteorites, ranging from a few hundred million years up to 2.2 billion years, are obtained. These ages are systematically larger by a factor of about 1.5 than those ages which are determined by the Cl^{36}, Ar^{36}, or similar methods for the same meteorites. Obviously, the production rates of cosmogenic nuclides during the last few million years exceeded their average values during the whole lifetime of the meteorites in interplanetary space. (auth)

30745 COSMIC-RAY EXPOSURE AGES AND TERRESTRIAL AGES OF STONE AND IRON METEORITES DERIVED FROM Cl^{36} AND Ar^{39} MEASUREMENTS. E. Vilcsek and H. Waenke (Max-Planck-Institut für Chemie, Mainz). p.381-93 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (In English)

In the course of this work about 50 meteorite samples were analyzed for chlorine-36 and argon-39. The measurements include those on separated metal fractions of stone meteorites to study the loss of mass of the meteorites during their passage through the earth's atmosphere. It could be shown that this loss is rather small and one does not see any significant difference between stone and iron meteorites. Comparisons of argon-39 with chlorine-36 data and also of both these isotopes with other measurements on cosmic-ray produced radioactive isotopes per-

mit the calculation of the terrestrial ages of the meteorites. These ages range between several hundred years up to more than 1.5 million years (Myr), and, on an average, were orders of magnitudes higher than generally thought up to now. By combining the chlorine-36 and argon-39 figures with the rare-gas data of the same samples, extensive statistics were obtained on precise determinations of cosmic-ray exposure ages available so far. The most significant results can be summarized as follows: (1) The exposure ages of the iron meteorites are in general much higher than those of the stone meteorites, even if one takes into account that the ages of stone meteorites generally tend to be found too low, because the diffusion losses of cosmic-ray produced rare gases seem to be higher than usually assumed. In the case of stone meteorites, measurements of the separated metal phase were utilized using a newly developed technique of fractionated dissolving. With this method it was possible for the first time to make an almost 100% separation of the metal phase of the stone meteorites. (2) The octahedrites with small and medium masses have high and nearly equal exposure ages (about 500 Myr), whereas the hexahedrites show big variations in the exposure ages (4 to 350 Myr). (3) Different samples of all very big meteorites very frequently show different exposure ages, indicating subsequent collisions of the meteoritic bodies in space. Great effort was made to study this effect in detail. (auth)

30746 TERRESTRIAL AGES OF METEORITES FROM COSMOGENIC C^{14}. T. P. Kohman and P. S. Goel (Carnegie Inst. of Tech., Pittsburgh). p.395-411 of "Radioactive Dating." Vienna, International Atomic Energy Agency, 1963. (TID-18443) (In English)

Techniques were developed for the isolation and measurement of cosmogenic C^{14} in meteorites. For stones, 10 to 40-g samples are decomposed with an oxidizing flux in a closed system. For irons, 150 to 400-g samples are dissolved in nitric acid in a stream of oxygen, sweeping out bound and cosmogenic carbon but leaving behind graphite. The C^{14} is counted as highly purified CO_2 in small low-level proportional counters. In 9 stone "falls" the C^{14} activity ranges between 49 and 78 disintegrations/min kg and averages 62.5 ± 9.5 disintegrations/min kg. The variations are mainly due to variations in the oxygen contents of the meteorites. Among 8 stone "finds," two have C^{14} contents at the contemporary level, indicating terrestrial ages of less than 3000 to 5000 yr (2σ criterion). Others contain lower C^{14} levels, showing that many stone "finds" are thousands of years old. The Potter, Nebraska, chondrite showed no C^{14}[≤4.5 disintegrations/min kg 2σ limit], and accordingly has a terrestrial age of ≥21000 yr. The stony-iron Admire is 11000 ± 1500 yr old. In iron "falls" C^{14} was measured as 1.80 ± 0.25 disintegrations/min kg in Aroos and 1.66 ± 0.37 in Sikhote Alin. The C^{14}/Be^{10} ratio averages 0.5 ± 0.1, and is believed to be rather independent of meteoroid size and specimen depth. For dating iron "finds," the C^{14}/Be^{10} ratio is used. Where Be^{10} has not been measured but Cl^{36} has, the former is estimated from the latter using correlations between the two. For crater-associated irons, the resulting ages in years are: Henbury, ≤4700; Boxhole, 5400 ± 1500; Odessa, 11000 ± 4000 or, conservatively, ≥6300. For smaller iron "finds": Carbo, ≤6900; Sardis, $\geq 10^4$. Some irons seem to be low in Cl^{36}, indicating long terrestrial ages. Sardis, with 3.7 ± 0.2 disintegrations/min kg (as compared to 6-20 for other non-crater irons) may have a terrestrial age approaching 10^6 yr, while Ider, with ≤0.4 disintegrations/min kg, probably fell more than 1.6×10^6 yr ago. (auth)

30747 MULTIPLEX RADIOACTIVITY WELL LOGGING SYSTEM. Glen Peterson (to Well Surveys, Inc.). U. S. Patent 3,091,695. May 28, 1963. Filed Nov. 8, 1954.

A multiplex well-logging system, in which a number of channels of information may be sent simultaneously from the subsurface detector to the surface recording apparatus, is patented. The system utilizes a plurality of self-balancing nulling systems and transmits all signals over a single insulated conductor. A dynamic condenser is used, which may be driven in two directions at two driving frequencies and provides a derived modulated signal at a derived frequency, which is the sum or difference of the driving frequency. A plurality of detectors in the subsurface unit produce electrical signals, which are converted to a-c and modulated by the dynamic condenser. The design of the condenser and the design and circuitry of the entire system are described in detail. (M.P.G.)

HEALTH AND SAFETY

Refer also to abstracts 29974, 29982, 29983, 29991, 29995, 30006, 30032, 30075, 30076, 30077, 30080, 30083, 30088, and 31550.

30748 (AERE-M-1169) THE POSSIBLE RADIOLOGICAL HAZARDS FROM TRITIUM SOURCES ABSORBED ON TITANIUM. J. A. B. Gibson (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 1963. 8p.

The rate of evolution of tritium from tritium sources absorbed on titanium was measured with a flow ionisation chamber to assess the possible hazard that may arise from these sources. It was found that the rate of tritium evolution was less than 20 microcuries per 8 hours per curie of absorbed tritium. It seems unlikely that the evolved tritium would present an ingestion or inhalation hazard. The bremsstrahlung radiation was also measured and would be a negligible hazard under normal circumstances. Sources used as targets for particle accelerators may present ingestion or inhalation hazards due to loss of particulate material if the sources are stored in the open laboratory. (auth)

30749 (HW-76553(Rev.)) CRITICAL MASS CONTROL SPECIFICATION HOOD 9A. R. J. Sloat (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 31, 1963. Contract AT(45-1)-1350. 7p.

Nuclear safety in hood 9-A depends on controlling the mass and geometry of the plutonium compounds not confined by the processing equipment. It is specified that plutonium concentrations in plutonium oxalate slurries and filter cakes allowed to accumulate in volumes in excess of 4 liters should be limited to a maximum of 1.0g Pu/cc in the process equipment. It was concluded that the critical mass of nonconfined plutonium may exceed 7 kg for dry, unmoderated plutonium compounds. Moderation of a reflected 2.5-kg plutonium mass could make it critical in an active volume of about 8 liters. (M.C.G.)

30750 (HW-77533) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD, JANUARY–MARCH 1963. R. H. Wilson, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1963. Contract AT(45-1)-1350. 28p.

Comprehensive surveillance of the occurrence of radioactive materials in the air, water, and foodstuffs has been continued in the vicinity of the Hanford plant. Gross beta activity in air during the first quarter of 1963 remained at the levels persisting since September 1962, following resumption of USSR nuclear testing. Iodine-131 in milk from farms in the neighborhood of the Hanford plant averaged less than 4 $\mu\mu$c per liter, the maximum individual sample being only 12 $\mu\mu$c per liter. Natural radiation background with some contribution from world-wide fallout continued to be the primary source of environmental exposure for most persons in the Hanford environs. Cooling water from the reactors, which is discharged to the Columbia River, continued to be the low level waste streams with the greatest potential for contributing to the radiation exposure of persons in the environs of the plant. For the 12 month period ending March 1963, the estimated dose to the GI-tract for persons drinking Pasco sanitary water was about 2% of applicable limit recommended by the National Committee on Radiation Protection and Measurements (NCRP). Residents of Kennewick using Columbia River water probably received about one-third as much. Concentrations of radiophosphorus found in whitefish were significantly lower than observed during the same period in 1962. For a few persons who eat them in quantity, locally-caught fish continued to be the major source of radioisotopes. Summing of exposure from various sources in a manner that tends to maximize the total dose to an individual leads to estimates of about 10% of the NCRP maximum permissible exposure for the GI-tract, about 15% of the FRC guides for the total body, 1% to the adult thyroid, and about 30% of the NCRP maximum permissible rate of intake for bone seeking radionuclides. (auth)

30751 (HW-77963) MODEL STUDIES OF BUFFERED SHIPPING CONTAINERS FOR FISSION PRODUCTS. Final Report. E. A. Ripperger (Texas. Univ., Austin. Structural Mechanics Research Lab.). May 1963. Contract AT(45-1)-1673. 111p.

Results are reported of some impact tests of one-quarter-scale models of a buffered shipping container for fission products. In these tests, the models were dropped in various orientations on a hard unyielding surface. Also, some models were dropped on obstructions, such as a short stiff stake, and the edge of a steel platform. Accelerations were measured at or near the CG of the container during impact. The results of tests of rubber-buffered containers indicated that these containers are quite rugged and can withstand impact at 44 fps on a hard unyielding surface without exceeding the 50-g design acceleration. Aluminum-honeycomb-buffered containers were equally rugged, but the tests indicated that some modification of the honeycomb arrangement is necessary if the design acceleration is not to be exceeded. The drops on obstructions indicated that with the exception of the short stiff stakes, impacts on obstructions produce no greater accelerations than impacts on flat surfaces. The buffering system was somewhat vulnerable, however, to penetration by stakes and pins. Static loading tests of a one-half-scale filter unit indicated that the filter is more than rugged enough to withstand accelerations of 50g. (auth)

30752 (IDO-12030) PRESSURE CEMENTING OF WATER WELLS ON THE NATIONAL REACTOR TESTING STATION, IDAHO. W. Scott Keys (Idaho Operations Office. Health and Safety Div., AEC). June 1963. 27p.

The purpose of pressure cementing water wells is to prevent the vertical migration of contaminated fluids between the casing and the wall of the hole. This is accomplished by forcing a neat cement grout upward in the annulus behind the casing. Cementing experience at the National Reactor Testing Station is described. Preparation of wells, cementing techniques, equipment, and materials are described. Methods for evaluating the completed cement job are geophysical logs and water analysis. Costs of $1500 to $3600 per well are justified to help protect water supplies from contamination. It is recommended that this type of construction be used on all production wells drilled on the NRTS in the future and on disposal and observation wells where needed. (auth)

30753 (MSAR-63-19) EXTINGUISHMENT OF ALKALI METAL FIRES. Quarterly Progress Report No. 3, September 15 to December 16, 1962. S. J. Rodgers and W. A. Everson (MSA Research Corp., Callery, Penna.). Jan. 14, 1963. Contract AF33(657)-8310. 12p.

A study is made of methods and extinguishants for extinguishing alkali metal fires. Results of inert gas blanketing and low oxygen partial pressures on alkali metal fires are included. Properties of polyurethane foam and high boiling organic liquids as fire extinguishing agents are given along with such other agents as graphite, inorganic salts, carbon wool, mineral oil, and commercial products. (N.W.R.)

30754 (NAA-SR-Memo-8195(Rev.)) CRITICALITY STUDY. 15 W/O U–Zr ALLOY. Norman Ketzlach (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 10, 1963. Contract [AT(11-1)-Gen-8]. 53p.

Maximum safe batch sizes were determined for all process steps involved in the melting and casting operations, as well as in the subsequent fuel handling procedures, of 15 wt.% U–85 wt.% Zr fuel rods. Criteria for hydrided as well as unhydrided rods are presented. A method is presented for the determination of an equivalent fuel rod diameter so that criticality data developed for long rods can be used in establishing nuclear safety criteria for fuel rods of any length. Packaging criteria are presented for the safe storage and transport of the fuel materials in 30 × 30 × 30 in. birdcages as well as in 55-gallon drums. The criteria developed can be used to determine the maximum safe number of storage units in an array when each unit contains no more than 45% of the critical quantity of fuel in spherical geometry under optimum conditions of water moderation and reflection. This is independent of fuel composition. Thirty-three figures are given that were used in the development of this criteria. (auth)

30755 (SAM-TDR-63-1) A CYTOGENETIC STUDY OF SOME RADIUM DIAL-PAINTERS AND THEIR PROGENY. Niel Wald, Charles E. Miller, Wayne H. Borges, Jip Kim, and Allen Brodsky (Pittsburgh. Univ. Graduate School of Public Health and Pittsburgh. Univ. School of Medicine). Apr. 1963. Contract AF41(657)-361. 7p. (AD-406801).

Issued by School of Aerospace Medicine, Brooks AFB, Tex.

Preliminary cytogenetic analyses were performed on four radium dial-painters and the crude average exposure dose to their bone marrow was estimated. Two instances of increased aneuploidy and three of increased chromosomal aberrations were observed in the four subjects, who had cumulative average bone marrow doses of 800 to 1,400 rem obtained at an average dose rate of 20 to 35 rem a year. Cytogenetic analyses were also performed in the progeny of four dial-painters, selected because of a history of frequent miscarriages and congenital anomalies. Among these were three instances of definite congenital anomaly. Increased aneuploidy was observed in all three patients. Additional observations and increased knowledge about the dosimetric and cytogenetic methods used are necessary before these preliminary findings can be adequately interpreted. (auth)

30756 (TID-18813) PIQUA-ELK RIVER REACTORS SPENT FUEL SHIPPING CASK. Final Design Report. (Knapp Mills Inc., Wilmington, Del.). Apr. 1, 1963. Contract AT(11-1)-1028.

For 16 drawings relating to this report, see CAPE-1011.

The Piqua-Elk River spent fuel shipping cask, designed to transport 19 fuel assemblies from either reactor starting 120 days after reactor shutdown for refueling, is described. The maximum weight of the loaded cask is 30 tons and the dimensions are 55 in. dia × 108 in. high. The space envelope required for the cask and shipping structure is 7 × 10 × 10 ft. The cask system is composed of 6 major components: cask body, closure head, fuel basket, shipping structure, lifting yoke, and Elk River fuel assembly adapters. Internal surfaces are stainless steel and external surfaces are painted carbon steel. The annulus between the inner and outer shells is filled with lead shielding. The fuel basket is an aluminum cylinder in which 19 cavities were machined to receive the fuel assemblies. The cask is designed for dry shipment at atmospheric pressure. (M.C.G.)

30757 (TID-18993) CURRENT TRENDS IN NUCLEAR SAFETY RESEARCH AND DEVELOPMENT. Stanley A. Szawlewicz (Div. of Reactor Development, AEC). [nd]. 15p. (CONF-39-1)

From American Nuclear Society Meeting, Salt Lake City, Utah, June 1963.

Work in nuclear safety is discussed. Site selections for nuclear power plants including studies of reactor accidents are described. Plans for laboratory-scale investigations and mockup and full-scale reactor experiments for the study of accident phenomena are outlined. Studies of fission-product-release behavior are also described. (M.C.G.)

30758 (WT-808) EVALUATION OF TRAINING PROGRAM FOR RADIOLOGICAL DEFENSE PERSONNEL. V. B. Lamoureux (Federal Civil Defense Administration, Washington, D. C.). Dec. 1953. Project 22.1 [of] OPERATION UPSHOT-KNOTHOLE. 20p.

Field training was provided under actual nuclear explosion conditions for State and local civil defense personnel engaged in radiological defense planning. Selected trainees reported to the Nevada Proving Grounds where they completed a course of lectures and field exercises. All trainees were given security clearance to permit access to restricted areas and freedom of discussion with program directors, project officers, and other test officials. The trainees received background information useful to them in their preparation of radiological defense plans in their home States and communities. (auth)

30759 THE PRINCIPLE OF IONOMETRIC METHODS IN THE METROLOGY OF X AND γ RADIATION MEASUREMENTS. I. Leibovici and M. Grecescu (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 99-112(1963). (In Rumanian)

The difficulties involved in the definition of rigorous and universally valid units in the field of x and γ radiation measurements are primarily due to the fact that a very wide range of energy is used in medical and industrial radiology. The interaction of matter with the radiation is greatly dependent on the energy level of the latter, causing photoelectric effect, Compton effect, or pair formation on the one hand, or secondary effects, such as Compton scattering, annihilation of protons, and other secondary radiation, on the other. The energy transformation is completed by thermal, chemical, or optical effects. The interaction constant, the energy spent in pair formation, is very important in ionometric methods; in the case of air it is 34 ev. The ionometric method consists in the measurement of the total charge of a given sign, created by the irradiation of the unit mass of a standard gas, such as air at normal temperature and pressure. Air was chosen because of the similarity with soft tissue with respect to radiation and because of its easy availability. The problems involved in the definition of the roentgen are reviewed, pointing out the difference between exposure dose (r) and absorbed dose (rad) which is a purely energetic unit. (TTT)

30760 RADIATION HYGIENE IN AND AROUND A NUCLEAR POWER STATION. J. H. Martin (United Kingdom Atomic Energy Authority, Anman, Scotland). Atom, No. 81, 219-28(July 1963).

The operation experience of the Chapelcross power plant is discussed in relation to radiation safety. The Health Physics working staff is described briefly. The basic operations at Chapelcross are outlined, and the safety risks and precautions are given. Results are given for environmental monitoring of the air, effluent, soil, milk, sand, seaweed, and shrimps, and it is seen that the observed activities are due to fallout. (D.L.C.)

30761 WORLD-WIDE FALLOUT TO 1962. L. Machta and K. Telegadas (Weather Bureau, Washington, D. C.). Atompraxis, 9: 209-13(June 1963). (In English)

Recent findings on the seasonal and geographical distribution of fallout are summarized. Data are included on observed inventories of Sr^{90} to 1962. Predictions of fallout from stratospheric radioactivity are included. (C.H.)

30762 GAMMA RAY SPECTROSCOPY OF FALLOUT IN CENTRAL EUROPE AFTER THE RECOMMENCEMENT OF THE USSR'S NUCLEAR WEAPON TESTS IN FALL 1961. G. M. Tišljar-Lentulis. Atompraxis, 9: 214-17 (June 1963). (In German)

Data are presented on the content of Zr^{95}, Nb^{95}, Ru^{103}, Rh^{103}, Ru^{106}, Rh^{106}, Ba^{140}, La^{140}, Ce^{141}, Ce^{144}, and Pr^{144} from fallout in samples of rain and snow collected in Central Europe after the USSR nuclear weapons tests in the fall of 1961. Estimates are included of the relative radiation intensities to be expected from these fission products. (C.H.)

30763 PINE NEEDLES AS A BIOINDICATOR OF RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT. R. Szepke (Central Lab. for Radiological Protection, Warsaw). Atompraxis, 9: 218-19(June 1963). (In English)

The radioactivity in pine needles was found to be proportional to the fallout rate. The use of pine needles as a bioindicator of radioactive contamination of the environment by fallout is suggested. Results obtained near Warsaw from 1959 to 1961 are presented. (C.H.)

30764 STUDY OF AMBIENT RADIATION BY MEANS OF GAMMA SPECTROMETRY. Th. Franke, B. Rajewsky, and A. Schraub (Max-Planck-Institut für Biophysik, Frankfurt am Main). Atompraxis, 9: 219-21(June 1963). (In German)

A mobile gamma spectrometer was used for measuring fission product activities from fallout deposited on the ground. The equipment is illustrated and described. (C.H.)

30765 REMOVAL OF FALLOUT RADIONUCLIDES FROM WATER. C. B. Senvar and U. Yuecelik (Univ. of Ankara). Atompraxis, 9: 222-3(June 1963). (In English)

The following systems were tested for their scavenging capacity for fission products in rain and snow water: soil; activated carbon finely ground or with 1.5 mm or 2.5 mm grain size; river sand; permutite; soil plus sand (50/50 by weight); and soil plus activated carbon. Results showed that water containing fission products can be decontaminated fairly well by filtering through a layer of soil, sand, activated carbon, or suitable mixture of these. Best results were obtained using mixtures of soil and sand. It is suggested that this filtration method followed by boiling is a practical emergency method for the decontamination of water. Results are included on the decontamination of rain and snow water collected in Turkey in 1962, 2.5 months after the Russian nuclear tests of 1961. (C.H.)

30766 A PROCEDURE FOR DETERMINING SLIGHT α AND β ACTIVITIES IN SEA WATER. H. Kautsky and D. E. Schmitt (Deutschen Hydrographischen Institut, Hamburg). Atompraxis, 9: 224-7(June 1963). (In German)

Chemical precipitation, coprecipitation, and adsorption were used to prepare samples of sea water for analysis for trace amounts of α and β activity. The method was also used in the analysis of rain and surface waters for radioactivity due to fallout fission products, uranium, and radioisotopes. (C.H.)

30767 COMPARISON OF THE RESULTS OBTAINED BY MOBILE MEASURING UNITS IN DETERMINING AMBIENT RADIATION. Th. Franke (Max-Planck-Institut fur Biophysik, Frankfurt am Main); H. Gramberg, and A. Schraub. Atompraxis, 9: 227-32(June 1963). (In German)

Results of measurements of ambient radiation from fallout and from artificial radioactive preparations using several measuring instruments were compared. (C.H.)

30768 CANADA'S EMERGENCY HEALTH SERVICES. Can. Med. Assoc. J., 87: 1202-3(Dec. 1, 1962).

A review of the medical aspects of civil defense planning is presented. (H.H.D.)

30769 RADIATION AND YOU. D. W. Hendrickson. J. Am. Osteopath. Assoc., 61: 875-81(July 1962).

Aspects of radiation are discussed, such as discovery of x rays and radioactivity, current uses of radiation in industry and medicine which present hazards to humans, means of reducing dosage to the patient in radiodiagnosis, and safety measures recommended for radiologists and technicians to avoid overexposure. The use of fluoroscopy presents one of the most critical danger zones because of its apparent simplicity of operation. Skin burns have frequently been associated with its use in unskilled hands or by demands put upon the operators by physicians reducing fractures or attempting the removal of foreign objects. The use of timing apparatus is essential. Proper filtration, safe target-panel distance, proper accommodation of the eyes, and good sensitivity of the fluorescent screen are mandatory elements. Within the fluoroscopic room itself, the operator must be positive that his own protection, such as chair, apron, and gloves are faultless in construction, and last, but not least, that he use them. Because of the problem of genetic damage, it is recommended that x rays of pregnant women not be done until the third trimester, and that the need for x rays in pelvimetry be weighed against the genetic hazards existing. As a further precaution, it is suggested that roentgenographic examination of the pelvis of women in the child-bearing age should be avoided except during the time from the onset of menstruation to the time of ovulation. (H.H.D.)

30770 PLUTONIUM-239 AND OTHER NUCLIDES IN GROUND-LEVEL AIR AND HUMAN LUNGS DURING SPRING 1962. R. V. Osborne (Royal Cancer Hospital, London). Nature, 199: 143-6(July 13, 1963).

Some of the fissile nuclides resulting from nuclear weapon explosions may not undergo fission so these nuclides, together with neutron capture products, may be dispersed from explosions in the atmosphere. Many of these nuclides are α emitters and the comparatively high levels of natural α activity complicate their identification and measurement. A technique is described that employs an α spectrometer for the measurement of Pu^{239} and Pu^{240} directly in ground level air at concentrations as low as 5×10^{-17} c/kg despite the presence of naturally occurring Po^{210}. Results are reported from the analysis of atmospheric dust samples and samples of lung tissue. The relation of lung burden and atmospheric concentration of

radionuclides is discussed. The total Pu^{239} inhaled up to June 1962 by a standard man in England was calculated as of the order of 5 pc. (C.H.)

30771 CONTINUED X-RAY MICROANALYSIS OF RADIOACTIVE FALL-OUT PARTICLES DURING THE YEAR 1962. Manfred F. Rajewsky (Max Planck Institut für Biophysik, Frankfurt am Main). Nature, 199: 162-3 (July 13, 1963).

Radioactive fallout particles collected in 1962 were prepared on electron microscope grids, located by radioautography, and analyzed by electron microscopy. The characteristics of 11 particles are tabulated. The results indicate that Fe and Al frequently appear as inactive components of radioactive fallout particles. (C.H.)

30772 OBSERVATIONS OF FALL-OUT RELATED TO RADIOACTIVE AIR BORNE DUST PARTICLES ON VEGETABLES. Katsuzo Nakanishi (Osaka Municipal and Hygienic Lab.), Masaki Hanaoka, Chotha Fujimoto, and Nobumasa Nakayama. Osaka Shiritsu Daigaku Igaku Zasshi, 11: 233-7(Aug. 1962). (In Japanese)

Studies were made of the chemical and physical properties of large particles of radioactive fallout removed from various vegetables between Dec. 1961 and March 1962. The particles were between 50 and 200 μ in diameter and were very stable against heating and mechanical pressure. Their radioactivity was about 3,000 to 4,000 $\mu\mu$c/particle and was characterized by the $Nb^{95} + Zr^{95}$ peak with about 5% Sr^{90}. Measurements were made with a γ spectrometer. (C.H.)

30773 RADON-DAUGHTER IONS IN THE ATMOSPHERE. Marvin H. Wilkening (New Mexico Inst. of Mining and Tech., Socorro). 25p. (CONF-16-4)

From International Symposium on the Natural Radiation Environment, Houston, Tex., Apr. 1963.

Results of studies on the contribution of radon and its short-lived daughter products to active deposits in the atmosphere show that the net result of the thunderstorm effect is to provide an upward flux of radon-daughter ions from the ground to higher levels in the atmosphere. A similar flux could be expected from the top of the thunderstorm. This could account for some of the lead-210 (RaD) content of the stratosphere. Since the daughter-ion content is found to correlate well with the total small-ion content of the atmosphere as reflected by conductivity measurements, the measurement of radon-daughter ions becomes a useful tool in studying the atmospheric electrical environment. (auth)

30774 NATURALLY OCCURRING RADIONUCLIDES IN FOODS AND WATERS FROM THE BRAZILIAN AREAS OF HIGH RADIOACTIVITY. M. Eisenbud (New York Univ., New York), H. Petrow, R. T. Drew, F. X. Roser, G. Kegel, and T. L. Cullen. 26p. (CONF-16-7)

From International Symposium on the Natural Radiation Environment, Houston, Tex., Apr. 1963.

A survey was made to determine the extent to which naturally occurring radionuclides are present in typical foods and waters of regions of high radioactivity in Brazil. Data are presented on the content of Ra^{228}, Th^{228}, and Ra^{226} in food and water samples. (C.H.)

30775 RADIATION PROTECTION DURING CATHETERIZATION OF THE HEART. G. Laessker. Thesis, Erfurt, Ger., Medizinische Akademie, 1962. 77p. $2.00.

Methods for radiation protection of personnel and patients during heart catheterization are discussed. Dose measurements in the vicinity of the x-ray tube are reported. By appropriate protection methods, radiation exposure can be reduced appreciably. (Gmelin Inst.)

30776 RADIOLOGICAL HEALTH IN INDUSTRY. J. R. Brown (Univ. of Toronto). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1108, 12p, $1.00. (CONF-1-2).

From Summer Meeting, Toronto, June 1963.

The uses of ionizing radiation in industry are reviewed and measures which may be adopted to prevent the exposure of personnel discussed. The need for constant vigilance and the proper control of sources of ionizing radiation at all times is emphasized. The need for specialized training in the field of radiological health is stressed. (C.H.)

30777 UF_6 CYLINDERS–SHIPPING CONTAINERS. (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-323(Rev.)).

The 11 drawings and 7 specifications in this package describe ten shielded containers. The withdrawal cylinder has an overall length of 3 ft but an actual tank length of 2.5 ft. It is 5 in. ID and fabricated from seamless Monel metal pipe. The cylinder's filling capacity is 55 lb of UF_6 of any enrichment. The 2.41-ft^3 cylinder is 53 in. in overall length with the tank 40.25 in. long and 12 in. ID. The walls are not less than 0.200 in. thick of 99% pure nickel. The product-handling cylinder is 81.5 in. long and 30 in. ID with a minimum wall thickness of 0.406 in. It has a filling capacity of 5,000 lb of UF_6 at ≤2.0% enrichment in U^{235} and H/U^{235} atomic ratio ≤3.7. The 10-ton cylinder is 48.25 in. ID × 9.876 ft in overall length. It has a filling capacity of 21,500 lb of UF_6 at U^{235} enrichments ≤2.0% and H/U^{235} atomic ratio ≤3.7. The nickel-withdrawal cylinder is 4.27 ft long, 8 in. ID and has walls 0.1875 in. thick of 99% pure nickel. The filling capacity is 250 lb of UF_6 with ≤12.5% U^{235} enrichment. The overall length of the 4-in. cylinder is 88 in. but the tank length is 16.5 in. with a minimum wall thickness of 0.096 in. It is fabricated of 99% pure nickel. The filling capacity is 5,000 g of UF_6 of any enrichment. The sample cylinder is 12 in. long, 2 in. OD, and is made of 0.065 wt. nickel. The top and bottom are 0.25 in. thick. Its filling capacity is 1,500 g of UF_6 of any enrichment. The Monel metal sample cylinder is 7.05 in. high, with the trap portion 6 in. long and 0.375 in. OD. It has a filling capacity of 15 g of UF_6 of any enrichment. The 5-ton container is not used for UF_6 but for other uranium compounds. It is fabricated of steel in the shape of a cone 6 ft high. The top nozzle is 18 in. ID, the bottom nozzle is 14 in. ID and a maximum of 5 ft OD. The filling capacity is 13,000 lb. The dolly, which is used to transport a 5-in. product cylinder, is 2 ft square at the base and 2.5 ft square at the top. It has 6 in. swiveled wheels for ease in unloading. It is constructed of 1.25 in. dia. pipe and is 3.16 ft high. (R.E.C.D.)

30778 SPENT FUEL SHIPPING CASK FOR PIQUA AND ELK RIVER REACTORS (Engineering Materials). (Knapp Mills Inc., Wilmington, Del.). (CAPE-1011)

This package contains 16 drawings and 2 specifications. The shipping cask is used to transport 19 spent fuel assemblies from the Elk River or Piqua Power Reactors. The fuel assemblies may be sent for refueling 120 days after reactor shutdown. The maximum weight of the loaded cask is 30 tons. The maximum weight of the cask including the shipping structure is 32 tons. Overall dimensions are 55 in. in dia × 108 in. high. The dimensions, including the required space envelope and shipping structure, are 7 ft wide × 10 ft long × 10 ft high. Internal surfaces are made of stainless steel and external surfaces are made of painted carbon

steel. Components of the cask system include cask body, closure head, fuel basket, shipping structure, lifting yoke, and the Elk River Power Reactor fuel assembly adapters. The body of the cask consists of cylindrical outer and inner shells with the annulus between the shells filled with lead shielding. The shielding is bonded to both shells to improve structural integrity and to provide maximum heat transfer. The closure head consists of flat cylindrical plates welded to a flanged carbon steel head. The fuel basket is an aluminum cylinder with machined cavities to receive the fuel assemblies of the Piqua Power Reactor. With aluminum adapters, it will receive fuel assemblies from the Elk River Reactor. The shipping cask is fabricated of structural steel shapes. The cask lifting yoke is a "C"-shaped structure which permits cask rotation during cask lifting. (F.E.S.)

30779 IMPROVEMENTS RELATING TO THE STORAGE OF MATERIALS HAVING A FISSIONABLE CONTENT. Thomas Hayward Gerrard and Ronald Richard Pender (to United Kingdom Atomic Energy Authority). British Patent 926,302. May 15, 1963. Filed July 29, 1960.

The design of a storage pillar for storing containers of fissionable material is patented. The pillar consists of 2 close-fitting concentric cylindrical tubes with axially spaced apertures. The tubes can be swivelled relative to each other so that the apertures line up, permitting access to compartments within the tubes, or so that the apertures are not lined up, closing the compartments. The inner tube has several transverse floors, so that containers may be stored in the compartments. Drainage space is provided below the floor of the lowest compartment, and holes are made in the floors to allow leaks to drain into the reservoir. A storage area would consist of a plurality of pillars spaced sufficiently far apart to prevent criticality of the material stored in the pillars. (M.P.G.)

30780 IMPROVEMENTS IN OR RELATING TO SYSTEMS FOR DETERMINING THE RADIO-ACTIVITY OF GAS SOLS. (to Philips Electrical Industries Ltd.). British Patent 927,225. May 29, 1963. Priority date Sept. 2, 1958, Netherlands.

A system for determining the radioactivity of aerosols is patented, in which the dispersed components in the gas are separated, and the intensity of α and β radiation emanating from the separated components is determined. Prior to detection, the radiation passes through thin sheets of material, the absorptive capacities of which are such that the ratio between detected α particles and detected β particles for the daughter products of Rn^{222} equals that for the daughter products of Rn^{220}. If the ratio between detected α particles and detected β particles is different, contamination is present. (M.P.G.)

30781 CLEANSING AGENT FOR RADIOACTIVE CONTAMINATION. David Gordon Stevenson, Alec Edward Oldbury, and Bayard Walter Ariss (to United Kingdom Atomic Energy Authority). British Patent 930,370. July 3, 1963. Filed Aug. 16, 1960.

Particulate or fluid radioactive material can be removed from a surface by applying a film-forming liquid material containing detergent to the surface and, subsequently, stripping the formed film from the surface. Suitable detergents and film-forming agents are discussed. (D.C.W.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

Refer also to abstracts 29963, 30025, 30026, 30028, 30035, 30045, 30053, 30054, 30144, 30169, 30170, 30171, 30172, 30173, 30175, 30176, 30177, 30178, 30179, 30180, 30181, 30182, 30184, 30186, 31088, 31760, 31761, 31762, 31763, 31764, 31766, and 30183.

30782 (TID-18036) APPLICATION OF RADIATION-PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER. Final Summary, October 1961–September 1962. D. Miyauchi, M. Eklund, J. Dassow, J. Spinelli, and N. Stoll (Fish and Wildlife Service. Technological Lab., Seattle). Apr. 1963. Contract AT(49-11)-2058. 48p.

30783 (ORNL-TM-584) ISOTOPES DEVELOPMENT CENTER REPORT. EXAMINATION OF NINE-YEAR OLD $Cs^{137}Cl$ SOURCE CAPSULE. K. W. Haff (Oak Ridge National Lab., Tenn.). Aug. 5, 1963. Contract W-7405-eng-26. 8p.

A 1540-curie $Cs^{137}Cl$ source made in March 1954 and placed in service at the Oak Ridge Institute of Nuclear Studies in 1955 was opened and examined to determine the effects of aging and continuous exposure to $Cs^{137}Cl$ and gamma radiation. No evidence of corrosion or deterioration of the source capsule could be detected by metallurgical examinations. (auth)

30784 (TID-19015) RADIOISOTOPES FOR COARSE ORE CONCENTRATION. Final Report, January 15, 1962. A. M. Gaudin and Harald Ramdohr (Massachusetts Inst. of Tech., Cambridge). Jan. 31, 1962. Contract [AT(30-1)-2329]. 47p.

The applications of radioisotopes for sorting coarse ore lumps according to copper content are investigated by two methods: selective adsorption of radioisotopes on certain minerals and exposure of minerals to a neutron beam to produce differences in activity. The development and operation of sorting devices employing a scintillation counter and flipping gate are described. (N.W.R.)

30785 (JPRS-20129) RESULTS IN THE PREPARATION OF CLOSED RADIOACTIVE RADIATION SOURCES IN HUNGARY. George Cserep and Vilmos Stenger. Translated from Energia Atomtech., 16: No. 3, 142-3 (Mar. 1963). 6p. (OTS-63-31261)

Procedures for the preparation of closed radiation sources are described. Radioisotopes used as radiation sources include Co^{60}, Zn^{65}, $Cs^{137}-Ba^{137}$, and Ir^{192}. (C.H.)

30786 ECONOMIC ASPECTS OF THE TECHNICAL APPLICATION OF RADIOISOTOPES. J. L. Putman (Wantage Research Lab., Delft, Eng.). Atom, No. 81: 213-18(July 1963).

A survey is presented of the ways in which the use of radioisotopes can affect the economy of the industrial processes and of some economic advantages of their use. Some of these ways include: thickness gages, radiographic testing, tracer applications, and industrial research. The various types of economic surveys are defined, and the results of national surveys made in U.K., U.S.A., France, Sweden, and U.S.S.R. of the savings due to radioisotope use are tabulated. The potential savings in some U.K. industries if they adopted uniform radioisotope techniques are also tabulated. (D.L.C.)

30787 THE UTILIZATION OF RADIOISOTOPES AS AN ENERGY SOURCE FOR SALINE WATER CONVERSION. Martin A. Welt (International Scientific Corp., Washington, D. C.). Dechema Monograph., 47: 373-414(1962). (In English)

Project Artesia proposes to convert fission product wastes into an energy source for saline water conversion. The radioactive aqueous waste material from reactor fuel element reprocessing plants is calcined to an insoluble powder and loaded by vibrational compaction into rods. A sufficient number of rods are loaded into a pressure vessel in which the heat is transferred to a suitable heat transfer fluid. This energy is then carried to a conventional saline water conversion system through an intermediate heat exchanger. The economic feasibility of an experimental test model is examined, and the cost is estimated to be $0.79/1000 gal. The technical aspects are next considered: radioactive material, materials selection, heat transfer, and compatibility analysis. Finally, the design and hazards of the experimental test model are described. (D.L.C.)

30788 STUDY ON THE APPLICATION OF RADIATION STERILIZATION FOR PRESERVATION OF FOOD. PART I. EFFECTS OF RADIATION ON THE QUALITY OF PROCESSED FISH-MEAT FOODS. Junichi Miyakoshi, Setsuo Kawamoto, and Naoshige Tani (Hitachi Shipbuilding and Engineering Co., Ltd., Japan). Hitachi Zosen Giho, 23: 235-40(Aug. 1962). (In Japanese)

Samples of several kinds of the processed fish meats were γ-irradiated by a 1,000-C Co^{60} source up to dosage range of 10^4 to 10^6 r. After irradiation, they were stored at 37, 6 to 8, and 0 to 5°C. The observed changes up to 82 days in flavor, effect on sterilization, color pH-value, and gas generation were discussed in comparison with those of the nonirradiated samples preserved under the same conditions. In summation, total sterilization in the case of fish meat can be achieved at about 5×10^5 r. However, at such dosage level, the meat flavor has become unsuitable. Hence, it is necessary to use a taste control agent. (OID)

30789 THE USE OF IONIZING RADIATION IN POULTRY FARMING. A. M. Kuzin, I. G. Kostin, L. N. Shershunova, and L. A. Zubareva (Inst. of Biological Physics, Moscow and Tomilinskii Poultry Plant, Radiobiological Lab., USSR). Radiobiologiya, 3: 311-16(1963). (In Russian)

It is known that a small irradiation dose during the embryonic period of development can stimulate the secretion of gonadotrophic substances which may lead to an increase in egg production and ability to hatch. Eggs from Russian White and New Hampshire hens were given a dose of one to three r in an incubator by using glass vials of uranyl nitrate salts as a radioactive source. The hatching rate of chicks from the irradiated eggs was 2 to 4% higher than in the controls, and it was found that the egg production of hens from the irradiated eggs was 5 to 15% higher than that of the controls. In a large-scale experiment, a total of 4170 eggs were subjected to a dose of 1.4 r over a period of 20 days. (The eggs were irradiated for only 5

minutes on the 1st to 3rd day of incubation because of the radiosensitivity of the embryo at this time.) The egg production of hens obtained from the irradiated eggs averaged 10% greater than that of the control hens. The irradiation of eggs in an incubator with controlled doses of gamma radiation can be recommended as a practical method of increasing ability to hatch and egg production. (TTT)

30790 CONTENT OF URANIUM, RADIUM AND THORIUM IN RIVER WATERS IN JAPAN. Yasuo Miyake (Meteorological Research Inst., Tokyo), Yukio Sugimura, and Hiroyuki Tsubota. 14p. (CONF-16-6)

From International Symposium on the Natural Radiation Environment, Houston, Tex., Apr. 1963.

Uranium, radium, and thorium contents in waters collected in ten representative rivers in Japan were determined. Average contents of these elements were respectively 0.57×10^{-6} g/l for uranium, 8.2×10^{-14} g/l for radium, and 2.7×10^{-6} g/l for thorium. It was noted that despite the abundance ratio of uranium and thorium in land materials of about 3, that of river waters was only 0.05 which suggests discrimination of uranium and thorium during weathering processes. It was also found that radium content in river waters in Japan is equivalent to only 34% on an average of the uranium supported radium in the equilibrium state. (auth)

30791 NUCLEAR RADIATION SYSTEMS ENGINEERING. L. J. Galbiati, Jr. (Mitre Corp., Bedford, Mass.) and G. T. Chase. New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1088, 21p, $1.00. (CONF-1-13)

From Summer Meeting, Toronto, June 1963.

A discussion is presented of the major considerations involved in the design of a system utilizing nuclear radiation for measurement and sensing applications. The various types of radiation of interest and the basic principles governing the interactions yielding vital parameter information are covered in a manner readily understood. The different methods of detecting radiation, along with a brief description of the physical phenomena involved, and a number of examples are presented. (auth)

30792 WHOLESOMENESS OF IRRADIATED FOOD. Nicholas Raica (Fitzsimons General Hospital, Denver), Marion E. McDowell, and William J. Darby. 32p. (CONF-27-1)

From International Conference on Radiation Research Commemorating the Operational Availability of the Radiation Laboratory for the Preservation of Food, Natick, Mass., Jan. 1963.

The wholesomeness of irradiated foods was evaluated in mice, rats, dogs, and monkeys over a 2-year period, or 4 generations. Data are presented on the effects of a diet containing radiation-processed foods on growth, reproduction, hematology, histopathology, carcinogenicity, and life span. (86 references) (C.H.)

30793 PROCESS FOR IMPROVING THE CROCKING AND COLORFASTNESS OF PIGMENT-PRINTED FIBROUS SHEETS BY IRRADIATION. Elliott J. Lawton and Howard C. Woodruff (to General Electric Co.). U. S. Patent 3,097,960. July 16, 1963. Filed May 28, 1956.

A process is given for producing textile pigment prints having very low crock (color transfer) characteristics. The process comprises forming the pigment composition with a binder which is polymerizable by electrons to a higher molecular weight, depositing the composition on the cloth, drying the cloth, and irradiating the pigment-printed surface with a dose of $\geq 10^6$ r of high-energy electrons. Some of the polymerizable binders which may be used are listed. (D.L.C.)

INSTRUMENTS AND INSTRUMENTATION

General and Miscellaneous

Refer also to abstracts 29886, 29887, 29888, 29895, 29935, 29965, and 30148.

30794 (AAEC/TM-194) A CRYOSTAT FOR TEMPERATURE CONTROL IN THE RANGE FROM AMBIENT TO -150°C. D. Roman (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Apr. 1963. 3p.

A simple cryostatic device that, by utilizing the latent heat of vaporization of liquid nitrogen, enables accurate control of temperature between ambient and −150°C is described. The advantages of this cryostat over other models known are simplicity of design and operation, ability to operate accurately from ambient to −150°C, economy, and large working space. (auth)

30795 (AD-258338) NGL PLATFORM NUCLEAR RADIATION PROGRAM. Bimonthly Report No. 6, March 23 to May 23, 1961. (Litton Industries, Beverly Hills, Calif.). June 1961. Contract AF33(600)-41452. 102p.

The results of combined nuclear and gamma irradiation on modified NGL components, as well as on certain transistors, diodes, and miscellaneous materials, are given. A preliminary comparison of the radiation environments of Convair's GTR and a flux converter in Argonne's CP-5 reactor is presented together with the dosimetry used to analyze the Argonne environment. The findings of an error analysis performed on the NGL gyro and accelerometer for both the Dayton (gamma) and CP-5 (nuclear) environments are reported. Included are all the data taken at Argonne. The Flight Data System is briefly analyzed in regard to its ability to withstand a nuclear radiation environment. (N.W.R.)

30796 (AERE-R-4305) A NEUTRON CRYSTALLOGRAPHY RIG DESIGN MANUAL. H. Bowes and R. F. Dyer (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1963. 23p.

A crystallography rig was installed at the Harwell PLUTO reactor to carry out studies on crystal structure by means of neutron-diffraction techniques. Several advances were made on the design of previous equipments, such as those currently in use at PLUTO and DIDO. The design described in this manual provides a source block and a three-beam collimator to fit one of the 7-in. horizontal holes in the reactor, each beam being dimensioned for a specific purpose. A tungsten-alloy gamma switch, mounted out-pile of the collimator, permits a selection of various beams and combinations of beams. Two monochromating crystals, mounted at the outer face of the tungsten switch, diffract neutron beams through tunnels in the out-of-pile shielding to two neutron spectrometers mounted on suitable platforms on the floor of the reactor. Details of the various components of the equipment are given, safety measures and the associated instrumentation and control system are described, and the special engineering aspects of the project are discussed. (auth)

30797 (CONF-22-12) FAST NEUTRON ISOCHRONOUS FLIGHT PATH SPECTROMETRY. Technical Report 292. M. L. Roush, A. S. Figuera, and W. F. Hornyak (Maryland. Univ., College Park). Feb. 1963. Contract [AT(30-1)-2464]. 40p.

From American Physical Society Meeting, January 1963.

A time-of-flight fast neutron spectrometer for continuous beams of neutrons is described. The spectrometer utilizes the isochronous principle that monoenergetic neutrons scattered from a hydrogenous medium arrive at a suitably oriented spherical surface after a fixed transit time. The scatterer ("start" detector) is a cylinder of NE-102 plastic scintillator 3 in. long and ½ in. diameter. The "stop" detector, also of NE-120, is a segment of a spherical shell with tapering thickness selected to obtain optimum resolution. This scintillator has a cap diameter of 18 inches with the radius of curvature of the spherical surface being 30 inches. A conventional time-to-pulse-height converter is used. Energy resolution of 9−14% was obtained for the energy range $1.8 < E_n < 10$ Mev. The efficiency, at 5 Mev, is estimated to be 1×10^{-3} per neutron incident on the scatterer. (auth)

30798 (CREL-1145) DIGITAL DATA STORAGE AND DISPLAY USING A MAGNETIC DRUM AND CATHODE-RAY SCREEN. C. G. Lennox and S. Shinmoto (Atomic Energy of Canada Ltd., Chalk River, Ont.). Mar. 1963. 41p. (AECL-1742)

A technique for the storage and display of the large quantities of information gathered in a complex industrial process is described, with particular regard to nuclear power plants. The approach described is all-electronic and is particularly suited for use with electronic data handling and computing units. A description is given of the method and circuits used to accumulate and to maintain up-to-date digital data on a magnetic-drum store and the interrogation of the store so that displays from it can be synthesized on a cathode-ray tube display screen. (auth)

30799 (SCTM-144-63(24)) A CONSTANT VOLT-SECOND PULSE SUPPLY. E. J. Bernard (Sandia Lab., Albuquerque, N. Mex.). July 1963. Contract [AT(29-1)-789]. 11p.

A technique for generating fixed-energy pulses is described. It is shown that a stability of better than 0.5% can be obtained with large changes in input voltage at a fixed temperature, and 1.7% with a 40°F variation in operating temperature. The investigation was conducted with 50-50 nickel–iron core materials. (auth)

30800 (TID-18997) SODIUM RESISTIVITY METER LOOP. Summary Report, June 1963. (Atomic Power Development Associates, Inc., Detroit). Contract AT(11-1)-865. 7p.

Modifications to the rhometer were completed, including the installation of an ambient temperature compensator component. A sodium hydride tea bag injection system was fabricated, and pure NaH was extracted in a dry-box process from high-grade commercial hydride in an oil dispersion. Final calibration of the sodium temperature compensator (after inclusion of the ambient temperature compensator) involved several temperature ramps in the 400 to 1000°F range. Circuit modifications are shown. (N.W.R.)

30801 (TID-19017) SODIUM RESISTIVITY METER LOOP. Summary Report, May 1963. (Atomic Power Development Associates, Inc., Detroit). Contract AT(11-1)-865. 6p.

Work has progressed on the rhometer temperature compensator to the point of successful operation at 900°F.

Two commercial, multiple-winding transformers were introduced to extend the incremental range of existing transformers. The new auxiliary transformers couple the voltage across the platinum temperature compensator resistance and the zero coefficient resistance into the signal summation loop of the original meter circuit. Compensation to 1000°F can be attained with only two ratio changes in transformers A and B, or three set points in all, including the original circuit, or 0 set point. (N.W.R.)

30802 (TID-19030) A NEW ELECTROMETER OF HIGH SENSITIVITY. Francis R. Shonka (Saint Procopius Coll., Lisle, Ill. Physical Sciences Lab.); G. Failla, and John E. Rose (Argonne National Lab., Ill.). [1963]. Contract AT (11-1)-323. 15p.

The electrometer consists of a movable quartz fiber element which, at zero potential, is in stationary equilibrium in a strong a-c electric field. A d-c signal on the fiber causes it to oscillate. The motion of the fiber is viewed in a microscope. Designed as a detector to establish a null between the d-c signal and a bucking voltage, the electrometer operates readily at sensitivities in excess of 5000 divisions per volt or nearly 10^{16} divisions per coulomb. Other features not common to existing electrometers include extreme ruggedness and stability, low inherent capacity, negligible geotropism, wide voltage range, portability, small size, and ability to measure its own contact potential. It is extremely non-linear and cannot be damaged or paralyzed by excessively large signals. The model has the disadvantage of viewing through a microscope. (auth)

30803 SPECTROMETRY OF FAST NEUTRONS BY MEANS OF THE REACTION $Li^6(n,t)He^4$. G. Gierts (CEN, Brussels). J. Nucl. Energy Pt. A & B, 17: 121-4(June 1963). (In French)

The possibilities of fast-neutron spectrometry in beam or isotropic geometry, deduced from the energies of the tritons of the $Li^6(n,t)He^4$ reaction, are discussed. A spectrum measured in a natural uranium slab is given. No advantage can be taken of the results below 150 kev, the differential neutron cross sections not being known below this energy. (auth)

30804 HIGH-PRECISION CUTTING OF Co–Fe SINGLE CRYSTALS FOR USE IN A NEUTRON SPECTROMETER. H. Beil, P. Carlos, and R. Genin (Commissariat à l'Énergie Atomique, Saclay, France). J. Phys., 24: Suppl. to No. 3, 15A-18A(Mar. 1963). (In French)

The construction of a polarized-neutron-beam spectrometer necessitated the development of a method for high precision cutting of single crystals of (Co–Fe). These crystals were used as polarizer and analyzer in the spectrometer. Accuracies to within ±3′ were obtained, which accuracy was appreciably better than the ±2° attainable in cutting when using Laue back-scatter photos. (auth)

30805 CONSTRUCTION OF A RAPID DISCRIMINATOR FOR USE IN TIME-OF-FLIGHT SPECTROMETRY OF FAST NEUTRONS. Robert Barjon, Yves Flamant, and Jean Lachkar (Université, Algiers). J. Phys., 24: 19A-23A(Mar. 1963). (In French)

A fast pulse-amplitude discriminator is described which is a part of a time-of-flight fast-neutron spectrometer. The resolving power of this discriminator is less than 0.3 nanosecond for 14-Mev neutrons. The formula giving the transit time in a threshold apparatus is derived by a direct method. (auth)

30806 APPARATUS FOR THE SEMI-AUTOMATIC DETERMINATION OF THE GAP DISTRIBUTION AND MULTIPLE SCATTERING IN PARTICLE PHOTOGRAPHY. P. Poubeau, H. Braun, and G. Baumann (Centre de Recherches Nucléaires, Strasbourg). J. Phys., 24: Suppl. to No. 3, 24A-30A(Mar. 1963). (In French)

An apparatus is constructed for measurements at high energies in nuclear emulsions. Two categories of measurements are automated: measurements relative to the granularity of discontinuous tracks; and measurements relative to multiple scattering. This apparatus allows a gain of time by a factor of about 6. (auth)

30807 APPARATUS FOR THE DETERMINATION OF VAPOR PRESSURES UP TO 20kg/cm² AND 500°C. R. Bessouat, H. Chavanel, and S. Elberg (Centre d'Études Nucléaires, Grenoble, France). J. Phys., 24: Suppl. to No. 3, 39A-44A(Mar. 1963). (In French)

The apparatus described is built for the study of organic coolants for nuclear reactors. Its principle is based on a null method. The device allows measurements up to 20 atmospheres and 500°C. Results of measurements made with diphenyl, terphenyls, OM2, OMP, and Dowtherm A are given. (auth)

30808 A MULTI-COIL MAGNETIC PROBE. D. E. T. F. Ashby, L. S. Holmes, and M. A. Kasha (United Kingdom Atomic Energy Authority, Culham, Berks, Eng.). J. Sci. Instr., 40: 364-7(July 1963).

A multi-coil probe for measuring the change of magnetic flux density within an intense gas discharge is described, together with the techniques used in its assembly and testing. An expression for its frequency response in terms of the measured parameters of the coils and their leads is given, which is valid, although the leads are not short compared with an electrical wavelength. (auth)

30809 OPERATING CHARACTERISTICS OF LARGE DIAMETER PHOTOMULTIPLIERS. I. SCINTILLATION-SPECTROMETRIC PERFORMANCE. Takeshi A. Iinuma (National Inst. of Radiological Sciences, Chiba, Japan). Japan. J. Appl. Phys., 2: 337-46(June 1963). (In English)

The scintillation-spectrometric performances for two types of 7 in. diameter photomultipliers (20th century VMP/11/170 and E.M.I. 9623) were investigated as a function of photocathode-first dynode voltage. The two types of tubes showed very different characteristics from each other that are due to differences in the electron-optical structures of photocathode-first dynode system. VMP/11/170 tubes showed the minimal spread in the pulse height distribution at 325 v, though the gain was not maximal. The optimal voltages for 9623 tubes were also determined. The mesh focusing electrode showed strange characteristics as a focusing electrode that may be explained as an additional dynode. The statistical analysis of the results with VMP/11/170 tubes indicated that the relative variance of the number of secondary electrons emitted from dynodes was changing with the energy of primary electrons. (auth)

30810 20 + 4 CHANNEL WIDE-BAND TIME ANALYZER. F. Szlávik and I. Pálmai (Central Inst. for Physics, Budapest). Kernenergie, 6: 209-14(May 1963). (In German)

A time analyzer with 20 primary-effect and 4 zero-effect channels is described, for which, in comparison to other similar units, the channel width changeable in broad limits and exactly defined as well as the very reliable method of working are prominent. After a critical comparison of the broadest multi-channel time-analyzer system, the construction, operation, and some wirings of the considered analyzer are described and the application possibilities of the multi-channel analyzer in measuring techniques and in automation are indicated. (tr-auth)

30811 PULSED OPERATION BEHAVIOR OF DUOPLASMATRON ION SOURCE. G. Petter (VEB Vakutronik, Dresden). Kernenergie, 6: 214-17(May 1963). (In German)

The characteristics of a duoplasmatron ion source according to von Ardenne in pulsed operation on supplying with hydrogen are described. From diagrams presented the optimal management for operation can be found, that is, the discharge parameters, for which the ignitions are normal and degree of modulation of the discharge current is a minimum. For measurement of the emission capability, a calorimetric method was used. The average emission current density amounted to 94 Å cm^2 for a diameter of the emission opening of 1.2 mm and a discharge current of 12.5 Å. In pulsed operation the ion currents are about a factor of 1.5 greater than in continuous operation. (tr-auth)

30812 SECTOR-TYPE MAGNETIC ANALYSER FOR THE INVESTIGATION OF ION RAYS. János Nagy. Magy. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 5: 25-34 (May 1963). (In Hungarian)

A sector-type analyzer magnet of 40° deflection was devised for the investigation of ion sources used in nuclear accelerators; the magnet is of symmetrical arrangement and suitable for determining the compositions of ion beams. With the stray magnetic field in front of the sector boundaries shielded, and ions of 10% energy spread assumed, data of the image slit or image distance were found to be in conformity with the calculations based on the image formation error, the velocity dispersion and the inlet slit data. The analyzer devised is also suitable for an automatic recording of the spectrum. Connected to the light-spot galvanometer (10^{-9} amp) of the Faraday cage, the post-recorder (Nachlaufschreiber) will draw the spectrum when the magnetic field is varied continuously. The latter purpose is served by a 230 ohm wire-wound resistor wound up on a spindle and rotated at uniform speed by an electric motor. One spectrum can be recorded in a few minutes. The ion source operated with 15 μ Hg D_2 gas containing a few percent of H_2 as well. The discharge vessel was made of silica. The individual components were identified by the data of the magnetic field. The ion ray contains ~63.5% of D_1^+ which can be determined directly from the peak heights since the energy spread of ions is less than 10% of the extraction voltage. The data obtained through automatic recording are in good accordance with the data of mass spectra obtained through direct measurements. (auth)

30813 TIME ANALYZER. V. V. Okorkov and D. L. Tolchenkov. Pribory i Tekhn. Eksperim., No. 2, 76-80 (Mar.-Apr. 1963). (In Russian)

A 160-channel time analyzer with minimum channel width of 0.2 μsec, registering several pulses per cycle, is described. The circuitry presented reduces the channel width to 0.2 μsec. (tr-auth)

30814 SINGLE NANOSECOND HIGH-VOLTAGE PULSE GENERATOR. B. G. Erozolimskii, L. N. Bondarenko, V. P. Prikholko, Yu. A. Mostovoi, A. K. Shevchenko, and Yu. G. Matveev (Inst. of Nuclear Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 2, 93-7(Mar.-Apr. 1963). (In Russian)

A generator forming a single voltage pulse transmits linear and high speed discharges and receives pulses with amplitudes up to 100 kv. The growth time of the voltage pulses is ~1 nsec and drop-off time is ~4 nsec. The generator is started by a pulse of 8 kv with a steepness of 100 kv/μsec. During this time the generator operation does not exceed 0.3 μsec. (tr-auth)

30815 SHORT PULSE GENERATOR WORKING IN THE FREQUENCY SEPARATION RANGE. A. A. Kurashov (Inst. of Atomic Energy, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 2, 102-4(Mar.-Apr. 1963). (In Russian)

A generator for short voltage pulses of high frequency is described. The pulse frequency fluctuation is smooth in the region of 1-10 kcs. The initial pulses are shifted in time. The phase shift between the input voltage and pulse output is well stabilized. The generator is used for the adjustment of a time analyzer, working on the vernier principle. (tr-auth)

30816 NUCLEAR MAGNETIC RESONANCE SPECTROMETER WITH STABILIZED MAGNETIC FIELD. B. I. Tetelbaum, N. A. Gilazov, and G. M. Luganskii. Pribory i Tekhn. Eksperim., No. 2, 111-13(Mar.-Apr. 1963). (In Russian)

A spectrometer with a constant magnetic field is described. The stabilizer is standard with a stabilization coefficient of ~2000. The magnetic field introduces an error of about 1-2% on the spectrometer measurements. (tr-auth)

30817 INDUCTION METHOD FOR MEASUREMENT OF SYNCHROTRON MAGNETIC FIELD IMPULSES. V. A. Vizir, V. N. Kuzmin, Yu. K. Netrov (Scientific Research Inst. of Nuclear Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 2, 137-9(Mar.-Apr. 1963). (In Russian)

Apparatus is described for the relative measurement of the instantaneous magnetic field impulse intensity. In developing the equipment, attention was given to decreasing the duration of the intermediate process in the measuring circuit to significantly reduce the lower limit of the measurements. The apparatus was adopted for measurement of the synchrotron magnetic field. (tr-auth)

30818 EMISSION FUNCTIONS OF DOUBLE-ROTOR NEUTRON CHOPPER. V. P. Vertebnyi and V. V. Kolotyi. Pribory i Tekhn. Eksperim., No. 2, 165-7(Mar.-Apr. 1963). (In Russian)

Neutron intensity and emission functions for a double-rotor neutron chopper are calculated as a function of neutron velocity for a system consisting of two rotors with axes perpendicular to the plane of the slits. In the coordinate system, fixed with respect to the rotors, the neutron trajectories are parabolic. The neutrons are emitted if their trajectories are not intersected by the walls of the slit. This condition limits the intake parameters as a function of neutron velocity for both rotors. The neutron intensity is proportional to the width of the rotor slits. (C.E.S.)

30819 THE 1958 He^4 TEMPERATURE SCALE. J. R. Clement (Naval Research Lab., Washington, D. C.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 67-74(1962).

The establishment of a temperature scale based on He^4, for use between 1 and 5°K, is described. (T.F.H.)

30820 MEASUREMENT OF TEMPERATURE BELOW 1°K. J. G. Daunt and D. O. Edwards (Ohio State Univ., Columbus). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 133-8(1962).

Paramagnetic methods for thermometry below 1°K are described. Attention is given to the measurement of the paramagnetic susceptibility, the applicability of different substances to paramagnetic thermometry, and the fundamentals of paramagnetic thermometry. (T.F.H.)

30821 RECENT EXPERIMENTS ON LIQUID HELIUM VAPOR PRESSURE MEASUREMENTS FROM 2° TO 4°K.

G. Cataland, M. H. Edlow, and H. H. Plumb (National Bureau of Standards, Washington, D. C.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 413-17(1962).

The vapor pressure of liquid He contained in storage Dewar Flasks is studied. The effects of several variables on the results are outlined. Temperatures of 2.1 to 4.2°K are included in the experimental study. Storage Dewars are used, rather than glass Dewars, because of the lower evaporation rate and resultant higher accuracy obtainable. (T.F.H.)

30822 THE USE OF REFRACTORY METALS FOR ULTRA HIGH-TEMPERATURE THERMOCOUPLES. J. C. Lachman (Hoskins Mfg. Co., Detroit) and J. A. McGurty. Temp. Meas. Control Sci. Ind., 3: Pt. 2, 177-87(1962).

The properties of refractory metal alloys for use in thermocouples capable of reliable operation at temperatures in the 3000 to 5000°F range and higher were investigated. The thermal emf of W–Mo and W–Re alloys relative to pure W is presented. For comparison the thermal emf of unalloyed refractory metal thermocouples are compared to Chromel–Alumel and Pt/Pt-Rh thermocouples. The W/W-26% Re thermocouples were found to be the most reliable. (C.E.S.)

30823 THERMOELECTRIC STABILITY PLATINUM VS PLATINUM-RHODIUM THERMOCOUPLES. R. J. Freeman (General Electric Co., Cincinnati). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 201-2 (1962).

An attempt was made to isolate apparent mechanical failures in noble-metal-sheathed thermocouple material and to develop techniques that would eliminate such failures from future applications. The properties of platinum-rhodium alloys vs. platinum as sheath materials were compared. The possibility of developing a thermocouple that is physically sound and thermoelectrically stable for 1000 hrs in the temperature range 2500-2600°F, when subjected to nuclear flux and temperature cycling, was investigated. Various thermocouple geometries were tested. BeO, MgO, and Al_2O_3 were used as insulators. (C.E.S.)

30824 THE EFFECT OF COLD WORKING, HEAT TREATMENT, AND OXIDATION ON THE THERMAL emf OF NICKEL-BASE THERMOELEMENTS. J. F. Potts, Jr. and D. L. McElroy (Oak Ridge National Lab., Tenn.). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 243-64(1962).

The behavior of thermocouples composed of nickel-base thermoelements was considered by systematically investigating the effects of cold working and annealing and oxidation. Evaluation of these effects was based on electrical resistance, metallography, hardness, dimensional changes, oxidation rates, and thermal emf studies. The major research emphasis was on Chromel-P and Alumel, but data are reported for 18 alloys. (C.E.S.)

30825 THE EFFECTS OF NUCLEAR RADIATION ON THERMOCOUPLES. M. J. Kelly, W. W. Johnston, and C. D. Baumann (Oak Ridge National Lab., Tenn.). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 265-9(1962).

Transmutation and nuclear alloying effects in Chromel-Alumel and platinum/platinum-rhodium thermocouples from a neutron flux of 10^{20} nvt were investigated. The irradiated thermocouples were calibrated against unirradiated thermocouples at 1000°C. The voltage deviations with respect to neutron exposure and temperature were presented. (C.E.S.)

30826 CALCULATED RADIATION INDUCED CHANGES IN THERMOCOUPLE COMPOSITION. W. E. Browning, Jr. and C. E. Miller, Jr. (Oak Ridge National Lab., Tenn.). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 271-6(1962).

Induced changes in thermocouple composition were calculated for irradiations in a thermal neutron flux of 10^{14} n-cm^{-2}-sec^{-1} for periods up to 20 yrs. The changes were calculated from known physical properties of the isotopes of the elements making up the thermocouple. Chromel, Alumel, iron, copper, Constantan, platinum, platinum-10% rhodium, tungsten, rhenium, and tungsten-26% rhenium were investigated. (C.E.S.)

30827 OPERATION OF THERMOCOUPLES UNDER CONDITIONS OF HIGH TEMPERATURE AND NUCLEAR RADIATION. G. F. Levy, R. R. Fouse, and R. Sherwin (Marquardt Corp., Van Nuys, Calif.). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 277-82(1962).

The amounts of de-calibration experienced by a thermocouple system under simultaneous temperature and nuclear irradiation conditions are measured for Pt/Pt-Rh, Pt/Pt-Rh-Pd, and Ir/Ir-Rh thermocouple systems. The investigations were carried out at 2500°F with a total integrated fast and thermal neutron flux of $(6\text{-}16) \times 10^{19}$ nvt. (C.E.S.)

30828 LIMITATIONS IN THE USE OF THERMOCOUPLES FOR TEMPERATURE MEASUREMENTS IN MAGNETIC FIELDS. Claire Loscoe and Herbert Mette (Army Signal Research and Development Lab., Fort Monmouth, N. J.). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 283-7(1962).

The effect of a magnetic field on the output voltage of thermocouple wires was investigated. Wires of Alumel, nickel, iron, Chromel, Constantan, and copper were studied. Extraneous magnetovoltages were produced not in the thermocouple junctions but in the thermocouple wires themselves. Two magnetovoltages, one independent of field direction and the other dependent on field direction, were identified. These magnetovoltages were produced as a result of temperature gradients in the wires. Attempts were made to eliminate these induced voltages. (C.E.S.)

30829 DRIFT STUDIES ON CHROMEL-P-ALUMEL THERMOCOUPLES IN HELIUM ATMOSPHERES. R. L. Bennett (Oak Ridge National Lab., Tenn.), W. T. Rainey, Jr., and W. M. McClain. Temp. Meas. Control Sci. Ind., 3: Pt. 2, 289-94(1962).

The use of Chromel-P-Alumel thermocouples under certain atmospheric conditions resulted in severe negative emf errors. These emf drifts were investigated in stagnant and flowing air and helium atmospheres with and without solid contaminants. Results indicated that the principal mechanism involved in the negative emf drift phenomenon was the selective oxidation of chromium in the 800-900°C region of the Chromel wire. Selective intergranular oxidation of the chromium occurred only in a limited temperature range and within rather critical limits of atmospheric oxidizing potential. (C.E.S.)

30830 MONOCHROMATIC RADIATION PYROMETRY OF HOT GASES, PLASMAS, AND DETONATIONS. Richard H. Tourin (Warner and Swasey Co., Flushing, N. Y.). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 455-66(1962).

Since gases have discontinuous emission spectra, optical pyrometric methods for the measurement of their temperatures must be confined to a narrow spectral band. An infrared monochromatic pyrometry method is described. Infrared light from a standard source is passed through the gas (flame, plasma, etc) whose temperature is to be determined. The light emerging from the gas is composed of the unabsorbed light from the standard source and the light emitted by the gas. This light is passed through a monochromator, and light at a particular wavelength (λ) is

selected by the monochromator. The light at λ is sent to a temperature-sensing device. Instrumentation and experimental results are described. (T.F.H.)

30831 SPECTROSCOPIC DIAGNOSTICS OF A GERDIEN-TYPE PLASMA STREAM USING ARGON. Wheeler K. McGregor and Milton T. Dooley (ARO, Inc., Arnold Air Force Station, Tenn.). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 467-77(1962).

Spectroscopic temperature measurements are made on the plasma from a d-c-arc, gas-stabilized source that has a Gerdien-type electrode configuration. The "peaking function" method is used in the measurements, and is applicable for temperatures of 8000 to 30,000°K. Methods for checking the experimental values are discussed. (T.F.H.)

30832 HIGH-TEMPERATURE SPECTRAL EMISSIVITY STUDIES ON REFRACTORY METALS AND CARBIDES. T. Riethof, B. D. Acchione, and E. R. Branyan (General Electric Co., Philadelphia). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 515-22(1962).

The normal spectral emissivities and normal total emissivities of W, Mo, Ta, TaC, and ZrC are measured at 1600 to 3100°K and 0.4 to 4μ wavelength. (T.F.H.)

30833 MEASUREMENTS OF THE THERMAL PROPERTIES OF METALS AT ELEVATED TEMPERATURES. R. L. Rudkin, W. J. Parker, and R. J. Jenkins (Naval Radiological Defense Lab., San Francisco, Calif.). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 523-34(1962).

A method is presented for measuring the total hemispherical emittance, heat capacity, and thermal conductivity of metals and alloys at high temperatures, using electrically heated wires in conjunction with photoelectric techniques for temperature determinations. Experimental results are presented for W, Re, and Mo at 1250 to 4000°K. (T.F.H.)

30834 THERMOCOUPLES FOR MEASUREMENT OF THE SURFACE TEMPERATURE OF NUCLEAR FUEL ELEMENTS. W. E. Browning, Jr. and H. L. Hemphill (Oak Ridge National Lab., Tenn.). Temp. Meas. Control Sci. Ind., 3: Pt. 2, 723-33(1962).

An outline is given of the fabrication, experimental and theoretical cooling corrections, and cooling-correction charts for thermocouples used on reactor fuel elements. Design features peculiar to reactor applications of thermocouples are discussed. (T.F.H.)

30835 PHOTOGRAPHIC INDEXING TECHNIQUE FOR EVALUATING EMULSION UNIFORMITY OF SPECTROGRAPHIC PLATES. J. M. McCrea (U. S. Steel Corp., Monroeville, Penna.). 21p. (CONF-74-5)

From ASTM Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963.

Emulsion variations on special-purpose spectrographic plates for detection of ions or invisible radiation greatly complicate use of these plates in quantitative analysis. In the conventional graded exposure technique for spark-source mass spectrography, different source-performance and emulsion-response factors may affect each exposure. Because magnet gaps are much less than plate widths, a simultaneous calibration for ion exposure cannot be obtained over the full width of a plate. As a result, "across-the-plate" emulsion variations are best studied by an independent method. Control indexing of plates by visible light is a useful technique for investigating emulsions and for improving precision of quantitative analysis. A convenient apparatus was constructed for exposing arbitrary 1- to 40-mm bands of full plate width to light under controlled conditions. These index bands may be applied either before or after the plate is used as an ion detector, and in such a manner that they do not overlap mass spectral lines. Photographic index bands or lines on mass spectrographic plates serve several important functions. They provide a permanent record of emulsion and processing uniformity, permit "in-batch" and "batch-to-batch" comparisons of plates on a common basis, and aid in comparison of processing techniques. Plates with major emulsion irregularities, such as severe across-the-plate variation in conjunction with relative uniformity along the plate, can be rejected by careful darkroom inspection prior to use, but index bands can be used to identify plates with variations not noticed during inspection. Until the incidence of rejectable plates in fresh batches is substantially reduced, all mass spectrograph plates used for quantitative purposes should bear index bands for recording evidence of emulsion uniformity. (auth)

30836 MULTICHANNEL PULSE ANALYSIS. G. S. Stanford (Argonne National Lab., Ill.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1065, 13p, $1.00. (CONF-1-16)

From Summer Meeting, Toronto, June 1963.

A review is present of the general principles and history of multichannel pulse analyzers. The features and performance of single-parameter and multiparameter analyzers are described, and trends in analyzer performance are discussed. (D.L.C.)

30837 INVERTED MAGNETRON TYPE MASS SPECTROMETER. Richard F. Herzog and Walter P. Poschenrieder (Geophysics Corp. of America, Bedford, Mass.). 7p. (CONF-74-3)

From ASTM Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963.

The simplicity and low-power consumption of the inverted magnetron-type mass spectrometer would be of advantage for space probes to analyze planetary atmospheres. A brief study was made of the performance and limitations of the instrument, and the results are described. It was found that under the present stringent weight limitations for space probe use, the resolution is too low to separate oxygen from nitrogen. (D.L.C.)

30838 USE OF SPARK SOURCE MASS SPECTROGRAPH AS A MILLIPROBE ANALYZER. Robert A. Wallace and John Roboz. 14p. (CONF-74-2)

From ASTM Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963.

A study was made on the use of a spark-source mass spectrograph for the analysis of striated metallic samples with zones less than 1 mm wide. Experiments were made on two types of artifical samples: a Cu base with a core of Ti containing 10 ppm Cu, and Al layers containing different impurity contents. The successful results indicate that the probe would be a useful tool in studying zones or inclusions of dimensions on the order of 0.1 to 0.5 mm. The selection of the probe material and geometry is considered. (D.L.C.)

30839 CONSTRUCTION OF AN INSTRUMENT FOR MEASUREMENTS OF STATISTICAL DISTRIBUTIONS OF RADIOACTIVE DECAY USING A NEW METHOD. W. Boehm. Thesis, Kiel, Universität, 1962. 47p. $2.00.

The construction of an instrument for measurement of probability distribution curves for radioactive decay is described. The instrument can be used for the determination of Gaussians for activities up to 10^6 dps. (Gmelin Inst.)

30840 A MOLECULAR BEAM DETECTOR WITH ELECTRON COLLISION IONIZATION AND QUADRUPOLE MASS FILTER. R. Wedemeyer. Thesis, Bonn, Universität, 1961. 87p. $2.00.

A molecular beam detector with ionization by electron collision is described. The detector operates with an ionization probability of 2.5×10^{-3} and a transmission of 0.5. The sensitivity of the instrument was calibrated with a Rb beam. The advantages of the detector in comparison to other molecular beam detection systems are discussed. (Gmelin Inst.)

30841 DEVICE FOR PRODUCING REGULATED RECTILINEAR MOVEMENTS. (to Societe des Forges et Ateliers du Creusot). British Patent 927,522. May 29, 1963. Priority date Aug. 6, 1959, France.

Rectilinear movement is provided by a screw-and-nut system, but provision is made for readily re-engaging the screw with the nut after the screw has been freed from the nut to carry out fast motion. (D.C.W.)

30842 ELECTRICAL SPARK-GAP. (to European Atomic Energy Community). British Patent 930,170. July 3, 1963. Priority date Oct. 21, 1960, France.

A spark-gap capable of closing readily and almost instantaneously an electric circuit through which a very intense current is to pass has a gap in the shape of a bell (solid of revolution). The external electrode has, at the top of the bell, one or two small trigger electrodes connected to elements for furnishing the appropriate electrical impulse. A double spark-gap using a central electrode common to both spark-gaps and placed between the two external electrodes is also described. (D.C.W.)

30843 ACCELERATION RESPONSIVE SWITCH. A. F. Chabrek and R. L. Maxwell (to U. S. Atomic Energy Commission). U. S. Patent 3,096,411. July 2, 1963.

An acceleration-responsive device with dual channel capabilities whereby a first circuit is actuated upon attainment of a predetermined maximum acceleration level and when the acceleration drops to a predetermined minimum acceleration level another circuit is actuated is described. A fluid-damped sensing mass slidably mounted in a relatively frictionless manner on a shaft through the intermediation of a ball bushing and biased by an adjustable compression spring provides inertially operated means for actuating the circuits. (AEC)

30844 TANK LEVEL MEASUREMENT SYSTEM. Jack G. Crump (to Industrial Nucleonics Corp.). U. S. Patent 3,098,154. July 16, 1963. Filed Dec. 15, 1958.

A radiometric apparatus for measuring the fill level in tanks or containers is designed which is linear over the range of measurement. The apparatus comprises a point radiation source and an elongated detector on opposite sides of the tank, and a compensating absorber positioned between the source and the tank. The block shape needed to achieve linearity is discussed. (D.L.C.)

30845 AN OPTIMIZING REGULATOR OF GAMMA RADIATION INTENSITY. E. M. Belov and I. E. Naats. Russian Patent 141,912. Dec. 29, 1960.

An optimizing regulator of gamma radiation intensity containing an amplifier and a scanning system either operated by a scanning oscillator or functioning in self-oscillation conditions, differs from others in that in order to maintain the maximum intensity of gamma radiation, it has reservoir capacitor cells with different time constants connected to the amplifier output. The time constants are such that the voltage in one of the cells is kept proportional to the maximum intensity in the course of scanning, whereas in the other one the voltage is kept proportional to the existing intensity. Equality of the voltages produces a reversal of the scanning. (OTS)

Radiation Detection

Refer also to abstracts 29898, 29971, 29985, 29986, 29987, 29988, 29989, 29993, 29994, 29996, 29997, 29998, 29999, 30000, 30001, 30002, 30003, 30004, 30082, 30086, 30087, 30093, 30095, 30096, 30097, 30099, 30100, 30101, 30102, 30103, 30104, 30105, 30106, 30109, 30110, 30111, 30169, 30170, 30171, 30174, 30732, 31057, and 31058.

30846 (CEA-2281) CONSIDERATIONS SUR LES PROBLEMES DE LA DOSIMETRIE INDIVIDUELLE DES RADIATIONS β, γ, X. (Consideration of the Problems of the Separate Measurement of β, γ, and X Radiation). H. Joffre (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 34p.

After an outline of the present state of knowledge concerning the determination of doses absorbed from external irradiation for various types of radiation, figures are given for the comparative sensitivity of common detectors. The criteria which have to be considered for the choice of the sensitive medium and of the nature and the thickness of the detector walls are given. Considered very generally, the detection assembly intended for measuring the dose absorbed at a given point in the organism must be designed with a view to giving the same overall interactions with the radiation considered as those occurring in the organism. (auth)

30847 (CONF-22-13) FAST ANALYSIS SYSTEM FOR BUBBLE CHAMBER DATA. Paul V. C. Hough (Brookhaven National Lab., Upton, N. Y.). Jan. 25, 1963. Contract [AT(30-2)-Gen-16]. 28p.

From American Physical Society Annual Meeting, New York, Jan. 1963.

The use of a flying-spot digitizer (FSD) in a system for analysis of bubble chamber data is discussed. The principles of the FSD are outlined, and the digital electronics problem associated with it is considered. The way in which the computer used for control of the FSD can make use of the mass of coordinate data to obtain Franckenstein-like points for particular events is described. (M.C.G.)

30848 (CONF-32-1) COMPUTER REDUCTION OF PULSE-HEIGHT DISTRIBUTION DATA FROM A WHOLE-BODY COUNTER. Donald C. Foster (Idaho Operations Office. Health and Safety Div., AEC). [1962]. 21p.

From Health Physics Society Meeting, Chicago. June 1962.

The application of high-speed computer techniques to the reduction of pulse-height distribution data from gamma spectrometry is discussed. Three programs written for use with an IBM 1620 computer are described. The first is a stripping program which successively strips normalized standard spectra from the sample spectra, calculates the amount of each isotopic contributor, and provides a residual spectrum after all the required subtractions are performed. The second analyzes complex spectra with up to six isotopic contributors present. The program solves a set of simultaneous equations based on the observed activities in the photopeak areas of the identified isotopes in the sample spectra. This program has the required standard data stored in the memory and a selection of the proper standard data is performed by the computer according to

coded information fed to the computer along with the sample data. The third program analyzes the entire pulse-height distribution, or any desired portion, considering the sample spectrum to be the linear sum of the constituents present plus an error function. The solution is by minimizing the error function using a least-squares technique. All three programs were written to utilize punched paper tape output data from a 420 punch unit coupled to an analyzer. Results obtained from analysis of known activities in a series of test cases are presented. (auth)

30849 (CONF-35-1) LARGE ACTIVE VOLUME, THIN ENTRY WINDOW SEMICONDUCTOR RADIATION DETECTORS. Chellis Chasman and Joseph Allen (Yale Univ., New Haven). Feb. 1963. Contract [AT(30-1)-1349]. 13p.

From American Physical Society Meeting, Cambridge, Mass., March 1963.

Using a contact configuration, it was possible to obtain energy resolutions of approximately 20 kev for alpha particles and 15 kev for beta particles in thick, lithium-drifted, silicon detectors cooled to −80°C. The electrical contact arrangement, which is easily and reliably fabricated, can withstand the repeated mechanical and thermal strain of cycling to low temperature. Since the particles enter through a gold surface barrier formed on the lithium-drifted wafer, the detector has a thin entry window and good energy resolution. (auth)

30850 (EUR-222.f) SPECTROMÉTRIE DES RÉACTIONS (n,α) ET (n,f) À L'AIDE DE DÉTECTEURS A ÉTAT SOLIDE. (Spectrometry of Reactions (n,α) and (n,f) by Means of Solid State Detectors). G. Fraysse and A. Prosdocimi (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. Central Nuclear Measurements Bureau, Geel, Belgium). 1963. 25p.

An application of surface barrier solid state detectors is made to the spectrometry of α particles and fission fragments. The characteristics of the reaction $B^{10}(n,\alpha)Li^7$ are deduced; and the reaction $Li^6(n,\alpha)H^3$, the emission of α particles by uranium, and the thermal neutron induced fission are analysed. The influence of self-absorption of α and fission fragments on their energy distribution shapes is displayed. (auth)

30851 (EUR-CEA-FC-197) DETECTEURS DE NEUTRES RAPIDES A EMISSION SECONDAIRE. (Detectors for Fast Neutrals Using Secondary Emission). N. Molho and F. P. G. Valckx (European Atomic Energy Community and France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Jan. 1963. 25p.

An apparatus for the production of a beam of neutron particles is described. A beam of ions from a small accelerator is partially neutralized by being passed through a very thin carbon foil. A detection system using secondary-emission characteristics is described, for use in flux measurements on the neutral beam. (T.F.H.)

30852 (GEAP-4222) IN-CORE INSTRUMENTATION DEVELOPMENT PROGRAM. DETECTORS FOR IN-CORE POWER MONITORING. Quarterly Progress Report, January–March 1963. R. A. DuBridge (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 1, 1963. Contract AT(04-3)-189. 30p.

The development and design of detectors for operating in ambient temperatures up to 1000°F for in-core power monitoring are discussed. Owing to the inherent temperature limitation of current integrating ion chambers in the reactor core caused by low resistance of insulators at high temperatures, some effort was applied toward the development of a thermocouple-type neutron detector for in-core power monitoring at temperatures where ion chambers cannot be successfully applied. The thermocouple-type detectors consist of a uranium alloy heater element inserted into a center-piece and swaged in a protective case so that heat is transferred almost totally in the radial direction. The difference in temperature caused by the fissioning uranium creates an emf in two thermocouples proportional to thermal neutron flux. The development of the neutron sensitive ion chambers consisting of enriched uranium is described. (N.W.R.)

30853 (HW-71359) TRIGGERED AURAL TONE GENERATORS FOR RADIATION MONITORING INSTRUMENTATION. E. M. Sheen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1, 1961. Contract AT(45-1)-1350. 6p.

Two circuits for triggered aural-tone generators are presented. The first is a compact, simple, four-transistor type with low power requirements for particular application in portable radiation survey instruments. The second circuit, for line-operated instruments, also uses four transistors; however, it requires a 115-24 VAC, 1A filament transformer and a 3.5 hy choke. In this circuit the output transistor is a power transistor and the circuit requires approximately 3 w of power during the pulse period in comparison with 60 mw for the first. Both units drive rugged, weatherproof, magnetic "howler speakers." (auth)

30854 (LNF-63/35) UN DISPOSITIVO PER LA FOCALIZZAZIONE E L'ANALISI MAGNETICA DI PIONI CARICHI FOTOPRODOTTI DALL'ELETTROSINCROTRONE DI FRASCATI. PARTE Ia. DESCRIZIONE TECHNICA DEI DISPOSITIVI COSTRUITI. (An Apparatus for the Focusing and Magnetic Analysis of Charged Pions Photoproduced in the Frascati Electrosynchrotron. Part I. Technical Description of the Apparatus Constructed). Note No. 200. G. Sanna (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). May 16, 1963. 21p.

A technical description is given of an apparatus for the focusing and magnetic analysis of charged particles that are photoproduced at the Frascati electrosynchrotron. The elements of the device that are discussed in some detail are the quadrupole magnetic lenses, the energy analysis magnet, pion source, circuitry, and vacuum system. The characteristics of the quadrupole lenses and the analyzer magnet are tabulated. (J.S.R.)

30855 (ORNL-3405) PROCESSING OF MULTICHANNEL-ANALYZER NUCLEAR REACTION SPECTRA WITH THE NEWDAC PROGRAM. J. B. Ball (Oak Ridge National Lab., Tenn.). July 16, 1963. Contract W-7405-eng-26. 21p.

A FORTRAN program is presented for processing pulse-height data for particles emitted from a nuclear reaction. The program corrects the particle energy for any absorber preceding the detector and computes the differential center-of-mass cross section as a function of the reaction Q value and the excitation energy of the final nucleus. The energies can be computed either relativistically or nonrelativistically. The program is written as a series of subroutines to facilitate possible expansion of the program and to allow easy accommodation of different data input routines. The output of the program is printed in tabular form and, at the discretion of the user, punched on cards for off-line plotting or for input to other programs. (auth)

30856 (SAM-TDR-63-21) EXPERIMENTAL CALIBRATION OF SEMICONDUCTOR DETECTOR PULSE-HEIGHT RESPONSE TO PROTONS. George W. Crawford, Thomas A. Alexander, Hartmut A. W. Spetzler, Joseph S. Pizzuto (School of Aerospace Medicine, Brooks AFB, Tex.); and James D. Hall (Texas Nuclear Corp., Austin, Tex.). Mar. 1963. 7p. (AD-406773).

Significant progress was made toward accomplishing measurement of the energy absorbed from a proton as a function of the path length of the proton in the sensitive volume of a semiconductor detector. Surface barrier p-n and p-i-n detectors were used in the study utilizing path lengths as short as 100 μ and as long as 10 cm. Protons of initial energy 16, 40, and 187 Mev were used. Other proton energies (8 to 166 Mev) were obtained by using absorbers in the proton beam. Energy calibrations were accomplished by total absorption of protons of known energy. (auth)

30857 (UCRL-10887) SPARK-CHAMBER PULSE MODULATORS. Quentin A. Kerns (California. Univ., Berkeley. Lawrence Radiation Lab.). June 1963. Contract W-7405-Eng-48. 22p. (CONF-60-1)

From WESCON, Institute of Electrical and Electronics Engineers, San Francisco, Aug. 1963.

The techniques of generating high-power electrical pulses for spark-chamber operation are discussed. In order to clarify the requirements that must be met by a spark-chamber pulse modulator, the typical operation and timing of a spark chamber system are described, together with the features of chamber operation and construction that affect modulator design. Values are given for a trigger amplifier that precedes the modulator. Existing modulator designs and power figures are discussed, with emphasis on the triggered gap as a modulator switching element. A developmental electron-triggered gap is described, which can significantly reduce time delay, rise time, and jitter. (auth)

30858 (USNRDL-TR-649) CONVERSION OF THE AN/PDR-T1B RADIAC TO A REMOTE AREA MONITOR. P. A. Covey (Naval Radiological Defense Lab., San Francisco). Apr. 24, 1963. 14p.

A reliable remote-area monitor was devised from two AN/PDR-T1B gamma survey meters by coupling the electronics of one unit, located at the readout position, with the ion chamber from a second instrument located at the remote-monitoring position. Cable lengths up to 50 ft were used with no appreciable signal degradation. The instrument is useful in fields up to 500 r/hr, and it has produced measurements agreeing with a standard NRDL Model 103 gamma intensity vs. time recorder (GITR) to within ±20%. (auth)

30859 (WCAP-2128) MINIATURE NEUTRON DETECTOR DEVELOPMENT. Final Report. J. Weisman, ed. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). June 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-2827. 17p.

Work on the development of miniature silicon carbide neutron detectors undertaken in the period from June 22, 1961, to June 1962 is reported. A major problem area is the development of surface junctions suitable for neutron detection. Diffusion techniques appeared highly promising for the production of such junctions. Accordingly a diffusion furnace for accomplishing this was set up and a diffusion process developed. Contacting and electrolytic etching procedures were developed for preparation of a diode suitable for radiation testing. The processes were successful and surface junction diodes capable of counting particles were produced. The ability to count particles at temperatures up to 700°C was demonstrated. Another important area is the evaluation of the junctions under simulated operating conditions. The equipment required for use in irradiation and annealing studies with the Van de Graaff generator was assembled. The equipment was used for evaluation of the SiC diodes at high temperatures. (auth)

30860 SCINTILLATION COUNTERS. Margareta Tibu. Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn., 12: 291-314(1961). (In Rumanian)

Scintillation counters make use of the ability of α particles to ionize and to excite ZnS molecules, generating light which is transformed into electric current by a photomultiplier. Uncharged particles are unable to ionize the gases directly; they can be detected only if they transfer a portion of their energy to an electron by the Compton effect, photoelectric effect, or pair formation. In the case of neutrons, an α particle must be formed by a (n,α) reaction. Transformation of the light into electric pulses by the photomultiplier results in a considerable increase of the counting rate. This is achieved by directing the light to the photocathode, causing the liberation of photoelectrons. The spectral sensitivity of the most used photocathodes, such as $Cs_3Sb-Sb-Na$, $Sb-K$, $Sb-K-Na$, and $Sb-K-Na-Cs$, are presented. The great amplification of the device, ranging from 10^6 to 10^9, causes a certain amount of instability in the system. The background noise level may be decreased by cooling but this presents some technical difficulties. The short duration of the pulses is very important for the resolution of individual counts; pulses of 6×10^{-10} sec were achieved with Ag–Mg alloy dinodes. The energy transfer mechanism by the excitation of vibrational states in organic and inorganic scintillators is reviewed. Gas scintillators, such as Ar, are useful for strongly ionizing particles, such as protons, α particles, and fission fragments. (33 references) (TTT)

30861 IONIZATION MEASUREMENTS ON VERY STEEP TRACKS OF SINGLY CHARGED FAST PARTICLES IN NUCLEAR EMULSION. P. Ciok (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Acta Phys. Polon., 23: 613-17(Mar. 1963). (In English)

A method for ionization measurements on very steep tracks of singly charged fast particles in nuclear emulsion is described. (auth)

30862 STUDY AND DESIGN OF A COMPENSATED IONIZATION CHAMBER. E. Artacho Savirón, J. Pérez Sánchez, and M. Balseyro Castro (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 59: 9-18(Jan.-Feb. 1963). (In Spanish)

A compensated ionization chamber was designed. This chamber has cylindrical symmetry, and the boron coating was done by the electrophoretic method. Its gamma and neutron sensitivity was studied as a function of the pressure and the gap between electrodes. The characteristics for different neutron fluxes showed the performance of this chamber. (auth)

30863 A MAGNETIC COINCIDENCE SPECTROMETER FOR THE MEASUREMENT OF SHORT NUCLEAR LIFETIMES. T. R. Gerholm and J. Lindskog (Univ. of Stockholm and Uppsala Univ.). Arkiv Fysik, 24: 171-98(1963). (In English)

The construction and performance characteristics of an electron-electron coincidence spectrometer with magnetic momentum selection are discussed. The instrument was specially designed for delayed coincidence measurements of excited nuclear energy levels down to a lower limit of

10^{-11} seconds. It is shown that the combination of a time-to-pulse height converter and an electron-electron coincidence spectrometer offers several advantages resulting in a lower limit for measurable lifetimes as well as an improved accuracy in the experimental results. (auth)

30864 IMPROVED EXPERIMENTAL METHODS FOR MEASUREMENTS OF NUCLEAR LIFETIMES DOWN TO 10^{-11} SECONDS. J. Lindskog and T. Sundstroem (Uppsala Univ.). Arkiv Fysik, 24: 199-220(1963). (In English)

Improved methods for delayed coincidence measurements of nuclear lifetimes down to 10 ps were developed. It is shown that when an electron coincidence spectrometer is used for the energy selection the measurements can in many cases be performed in such a way that the energy dependent instrumental time delays do not contribute to the measured lifetime. In addition these instrumental time delays were carefully investigated. (auth)

30865 FATIGUE EFFECT IN PHOTOMULTIPLIER. Tahir Husain (Government Coll., Lahore). J. Nat. Sci. Math., 3: 17-19(Apr. 1963).

The drift in gain and fatigue effects were studied in a photomultiplier after the tube had been used for several months. It is found that these effects can be minimized by taking as small an output current as possible (lower interstage potential and weak source), and leaving the E.H.T. on, with a weak source near it, so that the tube draws about 1 μamp output current at all times when the tube is not in use. (auth)

30866 THE DETECTION OF FAST NEUTRONS BY MEANS OF LIQUID-HEXANE-FILLED IONIZATION CHAMBERS. Daniel Blanc, Jacques Mathieu, and Paul Vermande (Centre de Physique Nucléaire, Faculté des Sciences, Toulouse). J. Phys., 24: Suppl. to No. 3, 31A-4A(Mar. 1963). (In French)

The use of a vacuum-tight polyethylene bag filled with hexane and inserted between the electrodes of the chamber keeps the liquid away from the walls and lowers the residual current below 5×10^{-14} A/cm^2, a value that is stable as a function of time. The ionization current is a linear function of the flux, with neutrons of 14.6 and 3 Mev, produced by D-T and D-D reactions; 85 per cent of this current is attributable to neutrons and 15 per cent to gamma photons accompanying them. The sensitivity is 400 n cm^{-2} s^{-1} (3 Mev), 1,000 n cm^{-2} s^{-1} (14.6 Mev), 10,000 photons cm^{-2} s^{-1} (Co^{60}). (auth)

30867 MOISTURE MEASUREMENTS BY MEANS OF A SCINTILLATION PROBE. R. Schroller and H. Stiede (Forschungsinstitut Manfred von Ardenne, Dresden). Kernenergie, 6: 218-24(May 1963). (In German)

Some viewpoints for the planning and construction of a scintillation probe for moisture measurements by means of neutrons are explained and measurement results with the probe are given. (tr-auth)

30868 ON THE QUANTITATIVE EVALUATION OF AUTORADIOGRAMS. Hilde Levi and A. W. Rogers (Universitet, Copenhagen). Kgl. Danske Videnskab. Selskab, Mat. Fys. Medd., 33: No. 11, 1-50(1963). (In English)

Results of an investigation into the possibilities for a quantitative interpretation of autoradiograms on the basis of grain counting or track counting are presented. The relation between track length, number of grains, and initial energy of the beta particle is studied, and the blackening produced by a point source of a beta emitter, e.g. carbon-14, surrounded by nuclear emulsion is described in terms of the distribution of grains in space. It is shown how an analysis of this type can be carried out for any pure beta emitter. However, the present measurements are confined to beta particles of up to 400 kev. (auth)

30869 INVESTIGATION OF A FLAT SCINTILLATION DETECTOR OF SLOW (THERMAL) NEUTRONS. E. P. Andreev, S. S. Rodionov, and I. Ya. Yaritsyna. Kom. Standartov, Mer i Izmeritel. Priborev, Tr. Inst. Kom., No. 55, 66-88(1961).

Certain characteristics of a flat, luminescent scintillation detector of slow (thermal) neutrons were investigated. The unit for testing the detector included the detector itself, a photomultiplier, broad band amplifier, counting device, and feeding stage. At a dose intensity of 5×10^3 microröntgen/sec, the detector is almost insensitive to gamma radiations. Its detecting sensitivity for thermal neutrons is $4.7 \pm 0.3\sqrt{2}$. (TCO)

30870 COMMENTS ON THE VACUUM REQUIREMENTS OF β-SPECTROSCOPES. Dénes Berényi. Magy. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 5: 35-8 (May 1963). (In Hungarian)

With the quantity of air present in beta spectrometers at various vacua expressed in a surface density of mg/cm^2 and using latest data on the range of electrons of a few kev energy, attempts were made to find the particular vacuum that will not interfere with beta-spectroscopic measurements. The following approximative relationship was found: under given conditions, the vacuum level should be selected in such a way that the quantity of air corresponding to the vacuum and expressed in surface density of mg/cm^2 as electron range will involve an energy about 100 times less than that of electrons whose examination by the spectrometer is unimpaired by other factors. (auth)

30871 THERMAL SELF-SHIELDING AND EDGE EFFECTS IN ABSORBING FOILS. J. L. Crane (Cornell Univ., Ithaca, N. Y.) and R. C. Doerner. Nucl. Sci. Eng., 16: 259-62(July 1963).

Self-shielding and edge corrections were investigated for varying thicknesses of 1 cm dia. gold foils. Test foils were irradiated in the hohlraum or air chamber of the TRIGA Mark II reactor. The self-shielding effect was determined from the activation of a series of foils of different thicknesses, and the edge correction from the activities of successively smaller concentric rings punched from the parent foil. Edge effects were found in the 2.5-mil and thicker foils, and were statistically significant only in the outer millimeter of the foil radius. After cutting off the outer millimeter of the foils, the activity was found to follow the $\frac{1}{2} - E_3(t\Sigma_a)$ law for infinite foils. (auth)

30872 A SULFUR–PHOSPHORUS ABSOLUTE FAST NEUTRON FLUX DETECTOR. G. A. Gilmour (Cornell Univ., Ithaca, N. Y.). Nucl. Sci. Eng., 16: 337(July 1963).

Threshold detectors composed of S-P mixtures are used for flux measurements on fast neutrons. P is incorporated into the detector in order to furnish a method for determining the counting efficiency of the counter. The counter is exposed to thermal neutrons with a known flux, and the P^{32} produced by the $P^{31}(n,\gamma)P^{32}$ is determined. The detector is then covered with Cd in order to prevent further P^{32} production by this mechanism, and is exposed to the unknown fast-neutron flux. The P^{32} produced by the fast-neutron reaction $S^{32}(n,p)P^{32}$ is then determined, and since the counting efficiency of the counter is known from the thermal-neutron measurement, the absolute fast-neutron flux can be calculated. (T.F.H.)

30873 200-LITER BUBBLE CHAMBER. M. F. Lomanov, A. G. Meshkovskii, M. S. Khopov, and V. A. Shchegolev (Inst. of Theoretical and Experimental Physics,

Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 2, 37-40(Mar.-Apr. 1963). (In Russian)

The construction of a 200-liter bubble chamber that uses a mixture of freon-12 and freon-13 in the weight ratio of 2:3 was described. The stopping of particles with ranges up to 80 cm can be observed in the chamber, corresponding to 360-Mev protons, 280-Mev mesons (K) or 200-Mev mesons (π). The maximum efficiency of γ detection in the chamber was 0.87. The chamber operates at room temperatures and can be used with mixtures of propane with ethane, xenon with propane, and other liquids. (tr-auth)

30874 BUBBLE GROWTH AND CONDENSATION IN BUBBLE CHAMBERS. Yu. A. Aleksandrov, G. S. Voronov, and H. B. Delone (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 2, 41-4(Mar.-Apr. 1963). (In Russian)

The process of vapor bubble growth and condensation in a superheated liquid is investigated, considering buoyancy effects. It is shown that buoyancy considerably affects the rate of growth and condensation of bubbles. A formula for the time rate of growth and condensation was used in the analysis of the process to derive the initial conditions and working efficiency of the chamber for the detection of rare events. (tr-auth)

30875 SPARK CHAMBER WITH SMALL NUMBER OF OBSTACLES ALONG PARTICLE TRAJECTORY. Yu. D. Bayukov, G. A. Leksin, D. A. Suchkov, and V. V. Telenkov. Pribory i Tekhn. Eksperim., No. 2, 45-7(Mar.-Apr. 1963). (In Russian)

A spark chamber and its high-voltage supply system are described. The chamber is part of an arrangement for the detection of secondary mesons in the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$. The main feature of the chamber is the small number of obstacles along the particle trajectory. The chamber electrodes were made of aluminum foil of 7 μ thickness and formed four spark gaps. The chamber works well with meson (π) beams. (tr-auth)

30876 LIQUID SCINTILLATION (n,γ) DETECTOR. L. B. Pikelmer, M. I. Pshitula, Kim Khi San, Ling-Yen Ch'êng, and E. I. Sharapov (Joint Inst. of Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 2, 48-50(Mar.-Apr. 1963). (In Russian)

A 400-liter liquid scintillation chamber was designed for the investigation of cross sections for (n,γ) reactions in time-of-flight experiments. The detector works on the double coincidence method, has low background, and an efficiency of ~30%. (tr-auth)

30877 SCINTILLATION DETECTOR FOR DETECTION OF NEUTRON SCATTERING. L. B. Pikelner, M. I. Pshitula, Kim Khi San, Ling-yen Ch'êng, and E. I. Sharapov (Joint Inst. of Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 2, 51-4(Mar.-Apr. 1963). (In Russian)

A scintillation detector for the investigation of neutron resonance scattering by the time-of-flight method is described. The detector efficiency is energy dependent and is ~10% for 100-ev neutrons and for γ radiation of three orders of magnitude lower. The lifetime of neutrons in the detector is ~15 μsec. The neutron resonance scattering spectra of Rh^{103} is presented. (tr-auth)

30878 DEVICE FOR PHOTOREGISTRATION OF DISCHARGES IN SPARK DETECTORS. I. V. Kolesov, V. F. Sikolenko, I. I. Skryl, and N. S. Frolov (Joint Inst. of Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 2, 54-8(Mar.-Apr. 1963). (In Russian)

A photoregistration device for photographing discharges in a spark detector is designed with two mutually perpendicular directions and an alignment system in one framework. The mirror and cylindrical lens system are computer adjusted with automatic cutoff. The operational precision of the system is about ±1 mm. (tr-auth)

30879 HIGH-EFFICIENCY DETECTOR FOR SLOW NEUTRONS ACTIVATED BY ZnS(Ag) + B_2O_3. V. V. Golikov, G. F. Shimchak, and A. A. Shkatula (Joint Inst. of Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 2, 59-62(Mar.-Apr. 1963). (In Russian)

A scintillation detector having an efficiency of 60% for thermal neutrons and ~10^{-4}% for Co^{60} γ radiation is described. A detector of this type has an area of 2000 cm^2 and uses four photomultiplier tubes connected to a coincidence selector. (tr-auth)

30880 DETECTION OF NUCLEAR FISSION IN HIGH BACKGROUND CONDITIONS. S. P. Almazova and V. P. Perelygin (Joint Inst. of Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 2, 63-6(Mar.-Apr. 1963). (In Russian)

A method for measurement of spontaneous fission of Np^{237}, Pu^{238}, and Pu^{242} and identification of anomalous short period fission was developed. The method eliminates background from light charged particles and γ rays in photoemulsions during the registration of fission particle tracks. By oxidation of latent images and an elimination process, fission fragment tracks are registered on the plate in background conditions of $10^{10} - 10^{11}$ α/cm^2 and 10^5 γ/cm^2. An enlargement process increases the efficiency for particle track examination. (tr-auth)

30881 ON ABSOLUTE ACTIVITY MEASUREMENT BY COINCIDENCE METHOD FOR GENERATION OF SEVERAL IDENTICAL PARTICLES IN EACH DISINTEGRATION. I. S. Panasyuk (Inst. of Atomic Energy, Academy of Sciences USSR). Pribory i Tekhn. Eksperim., No. 2, 66-8(Mar.-Apr. 1963). (In Russian)

An incident is investigated in which each radioactive disintegration in corresponding samples is accompanied by the isotropic emission of an arbitrary number of almost identical particles and registered by a double-coincidence method. New formulas were derived. If the number of particles generated in each disintegration were sufficiently large the results were comparable to a known formula for the double-coincidence method. (tr-auth)

30882 TWELVE-CHANNEL AMPLITUDE ANALYZER. B. Maly, V. S. Pantuev, and M. N. Khachaturyan (Joint Inst. of Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 2, 73-5(Mar.-Apr. 1963). (In Russian)

A pulse amplitude analyzer designed for nuclear spectroscopy is described. The continuous spectra pulses are divided into twelve distinct amplitudes and distributed along the channels by means of an LP-1 tube. The analyzer dead-time is 30 μsec, the channel width is 1%, and threshold stability is 0.2%. (tr-auth)

30883 DEVICE FOR REGISTERING PULSES FROM A LARGE NUMBER OF IONIZATION CHAMBERS. V. I. Sokolovskii, B. V. Sybbotin, and V. I. Yakovlev (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 2, 86-9(Mar.-Apr. 1963). (In Russian)

A device for the registration of pulses from one thousand ionization chambers is described. The pulse range reaches 2×10^4 (50 mv – 1 v). The device automatically determines the pulse amplitude with an accuracy of ±5%. The data can be recorded on magnetic tape for processing in an electronic computer. (tr-auth)

30884 DESIGN OF ELECTROMAGNETIC SCREEN FOR PHOTOMULTIPLIER TUBES. V. V. Matveev, E. E. Minaeva, and A. D. Sokolov. Pribory i Tekhn. Eksperim., No. 2, 116-20(Mar.-Apr. 1963). (In Russian)

The construction of an electromagnetic screen for photomultiplier tubes adaptable for scintillation counters is investigated. The screen is designed for constant magnetic fields. Magnetostatic parameters were used as a basis for the design. Experimental data for several types of screens were presented. (tr-auth)

30885 SIMPLE METHOD FOR GAMMA SPECTRA DETECTION UNDER PEAK ANNIHILATION RADIATION. N. A. Vartanov (Inst. of Physics and Tech., Academy of Sciences, Georgian SSR). Pribory i Tekhn. Eksperim., No. 2, 167-8(Mar.-Apr. 1963). (In Russian)

A simple method was proposed for the detection of gamma spectra with the energy $E_\gamma \approx m_0C^2$ under peak annihilation in a gamma scintillation spectrometer with a NaI(Tl) crystal. The method was applied to the β^+ isotope Sb^{119}. The annihilation spectra were also given for Na^{22}. (tr-auth)

30886 APPLICATION OF SILICON DETECTORS FOR ALPHA PARTICLES FROM LIQUIDS. M. V. Chukichev and P. A. Zagorets (Moscow Inst. of Chemical Tech.). Pribory i Tekhn. Eksperim., No. 2, 172-3(Mar.-Apr. 1963). (In Russian)

A silicon detector was effectively applied to determine the concentration of α-active elements in liquid solutions by measuring the intensity of the α particles emitted from the surface of the solution. The detector is in contact with the surface of the solution and registers only those α particles emitted in the detector alignment geometry. A formula for the radioactive-element concentration in the solution is given. The detector can be used to detect small concentrations of U^{233}, Ra, Po^{210}, and Pu^{239} in solutions. (C.E.S.)

30887 RADIATION MEASUREMENTS—COMPARISON OF RADIOLYSIS EFFECTS OF COBALT-60 GAMMA RAYS AND 3-6 Mev ELECTRONS ON NITRILE SYSTEMS. Gordon Holman Miller. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1962. 328p.

The object of this investigation was to develop a liquid chemical dosimeter, useful in the dose range from 10^6 through 10^8 rads or above, using nitriles; to determine the type and yield of radiolysis products of the nitriles; and to determine whether the high instantaneous dose rate of electrons from a pulsed linear accelerator has a radiolysis effect different from that of gamma radiation from Co^{60} as measured by changes in dosimeter products. High intensity gamma-ray and accelerated electron sources require liquid chemical dosimeters in the $10^6 - 10^8$ rad range for accurate dose measurement of intended research samples. Previously, there has been no fully adequate liquid dosimeter throughout the 10^8 rad range. It has also been necessary to determine whether accelerated electrons, with up to 4.8×10^5 times the instantaneous dose rate of Co^{60} gamma rays, would give the same G yield (molecules per 100 ev). Acetonitrile and benzonitrile were chosen as systems for evaluation. The experimental results show that the radiolysis CN yields from purified nitriles are an exponential function of dose. Irradiation in sealed tubes, screw capped vials, underwater or in air, gives substantially the same results, but sealed tubes in air are the most precise. Oxygen (air) and water in the samples alter the yield, but vessel size, temperature up to 140°F, light (visible and ultraviolet), and metals (Pt, Nichrome, Chromel A, stainless steel, Al, or Hg) do not. To measure absolute dose from the accelerator, a calorimeter was designed to absorb all of a collimated beam in the nitrile sample. The resulting temperature rise was converted to dose, and the chemical effect on the nitrile was determined. The electron and gamma radiation gave the same yield of hydrogen and under 10% difference in the CN yield. The methane yields were close but statistically different. The products were identified by a combination of mass spectrometry, high mass spectrometry, infrared spectroscopy, nuclear magnetic resonance and gas chromatography. Their formation can be accounted for by radiation bond rupture, hydrogen abstraction and random free radical recombination. Benzonitrile was found to be very radiation resistant; the hydrogen and methane yields were only 2 to 3% of those from acetonitrile. The following conclusions are drawn: purified acetonitrile makes a satisfactory dosimeter over the range 1×10^6 to 6.5×10^8 rads; the wt % yield of CN is an exponential function of the total dose in megarads and is given by the equation: $CN = 0.0050\ (dose)^{0.8245}$; the principal gaseous products are H_2(G = 0.58) and CH_4(G = 0.63) with minor yields of NH_3, C_2H_6, C_2H_2, N_2, HCN, C_3H_8 and C_4H_{10}; identified heavier products are C_2, C_3, and C_4 aliphatic nitriles, succinonitrile, malononitrile, and acetonitrile dimer (3-imino-butyronitrile); a complex polymer (G = 8) contains imine or amine and nitrile groups, the C–H–N proportions approach $(CH_3CN)_x$, and the measured CN yield used in the dosimetry is largely contained in the polymer; benzonitrile is appreciably more radiation resistant than acetonitrile and gives promise of a still higher level dosimeter; and the calorimetric method for absolute dose measurement is satisfactory and the accelerator radiation is not significantly different from the cobalt-60 radiation. (auth)

30888 THE STATE-OF-THE-ART IN NEUTRON DETECTION. Bach Sellers (Allied Research Associates, Inc., Concord, Mass.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1092, 18p, $1.00. (CONF-1-18)

From Summer Meeting, Toronto, June 1963.

It is concluded that the most useful devices for use in the average laboratory for measurement of neutron energy are semiconductors. When particularly fast time response or exceedingly high conversion values are required, the use of neutron scintillators or boron-containing chambers is indicated, particularly for thermal neutrons. The advent of the proton telescope using semiconductor detectors is of particular importance, as is the commercial availability of both He^3 and LiF sandwich spectrometers. (auth)

30889 SEMICONDUCTOR BETA AND GAMMA DETECTORS. R. W. Jackson (RCA Victor Co., Ltd., Montreal). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1082, 22p, $1.00. (CONF-1-12)

From Summer Meeting, Toronto, June 1963.

The principles of semiconductor nuclear particle detectors and their applications are reviewed and recent progress reported, with particular attention to the detection of beta and gamma radiations. By the lithium ion drift process, P-I-N structures with 5 mm depletion depth can now be fabricated routinely in silicon. Such counters have an efficiency of about 5% for the detection of gamma photons, and, when cooled, have shown energy resolutions of under 10 kev. Recent results using germanium, which has a much higher photoelectric absorption cross section, show the photoelectric peak well above the Compton background for the 660 kev gamma from Cs^{137}, and with a line width

less than 7 kev for the 120 kev gamma from Co^{57}. The possibilities of other materials for large volume particle detectors are discussed. (auth)

30890 APPARATUS FOR AND A METHOD OF DETERMINING THE SPECTRUM OF A SOURCE WHICH EMITS α RADIATION. Henryk Ludwick Zaborowski (to Commissariat a l'Energie Atomique). British Patent 925,629. May 8, 1963. Priority date Aug. 7, 1958, France.

An apparatus for determining the spectrum of an α-emitting radioactive source consists of a hemispherical receptacle, which can be mounted on a photomultiplier to make a fluid-tight seal. The interior surface of the receptacle has a reflecting scintillating coating, such as silver-activated zinc sulfide applied to polished metal. When operating, the receptacle contains a gas, the pressure of which can be varied. The α source is located at the center of the sphere, of which the hemisphere is a part. The spectrum of the source is determined by discontinuously varying the gas pressure and counting the output of the photomultiplier for each value of the pressure, or by continuously varying the gas pressure and counting the output of the photomultiplier as a function of time. Advantages of the apparatus include ease of operation, rapid determination of a spectrum, easy decontamination, and ruggedness. (M.P.G.)

30891 IMPROVEMENTS IN OR RELATING TO CONDENSER DOSIMETERS AND ELECTROMETER READERS FOR USE THEREWITH. Edmund Harry Cooke-Yarborough (to United Kingdom Atomic Energy Authority). British Patent 926,170. May 15, 1963. Filed Oct. 27, 1959.

The patented design of a condenser chamber dosimeter and an electrometer reader to be used with it provides for the inner electrode of the dosimeter and the input terminal of the reader to be capacitatively coupled together when making a reading. The dosimeter has 3 concentric electrodes. The polarizing electrode is close to the outermost electrode and is charged to a high potential, while the outer and inner electrodes are held at ground. When the chamber is irradiated, a charge flows from the polarizing electrode to the inner electrode, causing a potential difference, which is directly proportional to the dose received, to appear between the outer and inner electrodes. To read the potential difference, an electrometer is attached to the dosimeter. The inner electrode of the dosimeter has a recess into which the probe input terminal of the electrometer is inserted. The electrometer is concave and dimensioned to fit closely around the casing of the dosimeter to ensure that the probe will not touch the inner electrode. The electrometer does not change the voltage on the dosimeter, so that repeated readings will be the same, provided no radiation dose is received between readings. (M.P.G.)

30892 PROCESS AND APPARATUS FOR MEASURING RADIOACTIVITY. (to Osterreichische Studiengesellschaft fur Atomenergie mbH). British Patent 926,939. May 22, 1963. Priority date Dec. 5, 1959, Austria.

A method for measuring the artificial radioactivity of a sample of a gaseous medium is patented. The sample is passed through a filter, and the α and β activities of the filter are then measured simultaneously but independently from each other. The ratio of α to β activity is compared to the constant ratio of α to β activity for the natural radioactivity of the gas. Since the ratio due to natural activity does not fluctuate, a change in the ratio indicates the presence of artificial radioactivity. Details of the method and apparatus are described. (M.P.G.)

30893 NUCLEAR RADIATION DOSIMETER READER APPARATUS. George A. Work. U. S. Patent 3,098,156. July 16, 1963. Filed July 29, 1960.

A reader for use with a phosphate glass dosimeter adapted on exposure to uv to emit fluorescence in proportion to its absorbed radiation, is designed which has a high light output and can determine radiation exposures of less than 1000 r. The reader comprises a pulsed Ar or N_2 arc discharge lamp for producing the fluorescence in the glass and photodetector means for producing a current proportional to the fluorescence. A low-voltage d-c battery is used to energize both the lamp and the photodetector. (D.L.C.)

30894 GAMMA PROPORTIONAL COUNTER CONTAINING HIGH Z GAS AND LOW Z MODERATOR. Raymond Fox (to U. S. Atomic Energy Commission). U. S. Patent 3,098,944. July 23, 1963.

A gamma radiation counter employing a gas proportional counter is described. The radiation counter comprises a cylindrical gas proportional counter which contains a high atomic number gas and is surrounded by a low atomic number gamma radiation moderator material. At least one slit is provided in the moderator to allow incident gamma radiation to enter the moderator in the most favorable manner for moderation, and also to allow low energy gamma radiation to enter the counter without the necessity of passing through the moderator. This radiation counter is capable of detecting and measuring gamma radiation in the energy range of 0.5-5 Mev. (AEC)

ISOTOPE SEPARATION

30895 (NYO-8772) SEPARATION AND EXCHANGE OF ISOTOPES. Annual Progress Report, July 15, 1962–June 30, 1963. W. Spindel (Rutgers Univ., Newark, N. J.). Contract AT(30-1)-2250. 47p.

Results of O_2 isotope fractionation studies in an NO_2-containing thermal diffusion column are reported in which the rapid equilibrium in the system $2\ NO_2 \rightleftharpoons N_2O_4$ produces appreciable amounts of monomeric NO_2 at the hot wall, while at the cold wall the gas contains a much larger fraction of the N_2O_4 dimer. The studies revealed that the relative separation factors for N^{15}/N^{14} and O^{18}/O^{16} in the system are not related in a simple manner to the isotopic masses. A proposed explanation of the observed fractionation effects is presented. Data and discussion concerning separation factor measurements for the exchange reaction $N_2O_3^{16} + 3\ NO^{18} \rightleftharpoons N_2O_3^{18} + 3\ NO^{16}$ at −78° to −23°C and at room temperatures are presented for pressures of 7.4 to 9.5 atm. In other work, preliminary investigations of NO: $4\ NO \rightleftharpoons N_2O + N_2O_3$ are reported. Continued investigation of these reactions is planned in an effort to determine whether this reaction is responsible for the formation of N_2O during distillation of NO. (J.R.D.)

30896 IMPROVEMENTS IN OR RELATING TO DEUTERIUM ISOTOPE CATALYTIC EXCHANGE REACTIONS. (to Houilleres du Bassin du Nord et du Pas-De-Calais and Commissariat à l'Énergie Atomique). British Patent 925,923. May 15, 1963. Priority date Dec. 13, 1958, France.

A method of preparing deuterium-enriched H by isotope exchange between H and liquid NH_3 is patented. A catalyst of cesium amide and/or rubidium amide is used in solution in the liquid NH_3. The catalyst may also contain potassium amide. The catalysts have a high solubility in liquid NH_3 and make it possible to conduct the reactions in a temperature range of −70 to +70°C under the natural pressure of the liquid NH_3. The concentration of the catalyst should be from 0.05 to 10% by weight of the NH_3. (M.P.G.)

30897 AN ELECTROLYTIC PROCESS FOR THE ISOTOPIC ENRICHMENT OR FRACTIONATION OF HYDROGEN. (to Commissariat à l'Énergie Atomique and Houilleres du Bassin du Nord et du Pas-De-Calais). British Patent 926,488. May 22, 1963. Priority date Aug. 28, 1959, France.

A process for the isotopic fractionation of H by electrolytic decomposition of liquid ammonia is patented. Liquid ammonia containing an acid electrolyte, i.e., one which gives $(NH_4)^+$ ions, is electrolyzed by means of a direct current applied between a cathode and an anode. The cathode is made of Fe, Cu, Ni, or an alloy containing one or more of these metals, and the anode is made of carbon or graphite. The process can be carried out at atmospheric pressure or higher pressure. The temperature must correlate with the pressure to maintain the ammonia in the liquid state. Equipment for the process is described and illustrated. (M.P.G.)

30898 PROCESS FOR THE PRODUCTION OF HEAVY WATER. (to Ruhrchemie AG). British Patent 930,606. July 3, 1963. Priority date Oct. 11, 1958, Germany.

The deuterium content in the aqueous phase of the products obtained by the hydrogenation of CO at an elevated temperature in the presence of a catalyst including a metal of Group VIII can be increased by effecting the hydrogenation at a temperature below 220°C, at a pressure above 5 kg/cm^2, and at a space velocity greater than 250 v/v/hr. The CO and H conversion rate is held below 15% by volume of the total CO and H. An iron catalyst is preferable as is a space velocity of 500 v/v/hr and a CO−H conversion rate of less than 10%. (D.C.W.)

30899 PROCESS FOR THE ISOTOPIC ENRICHMENT OR FRACTIONATION OF HYDROGEN. Gregoire Dirian, Henri Sack, Fernande Botter, and Bernard Lefrancois (to Houilleres du Bassin du Nord et du Pas-de-Calais Douai). U. S. Patent 3,098,020. July 16, 1963. Priority date Aug. 28, 1959, France.

A process with high separation factors is given which consists of the electrolytic decomposition of liquid NH_3. In this process, an acid electrolyte, e.g., NH_4Br, is added to the NH_3, the electrolysis is carried out at low temperatures, and the cathode is made of Fe, Cu, Ni, or alloys of these metals. Two electrolytic cells are described, one for atmospheric pressure and the other for high pressure. Examples of the process are reported in which separation factors of 17 to 28 were found. (D.L.C.)

MATHEMATICS AND COMPUTERS

30900 (ANL-6716) TRANSFER FUNCTION SYNTHESIS AS A RATIO OF TWO COMPLEX POLYNOMIALS. C. K. Sanathanan and Judith Koerner (Argonne National Lab., Ill.). May 1963. Contract W-31-109-eng-38. 36p.

Experimental data for frequency response obtained from a linear dynamic system were processed to obtain the transfer function as a ratio of two frequency-dependent polynomials. The difference between the absolute magnitudes of the actual function and the polynomial ratio was the error considered. The polynomial coefficients were evaluated as the result of minimizing the sum of the squares of the errors at the experimental points. The magnitude and phase angle of the transfer function were evaluated at various frequencies by means of the computed polynomial ratio and were compared with the observed data. The numerical solution of this problem was obtained by using an IBM 704 FORTRAN program. The method presented gives an analytic description of the complex transfer function superior to that given by minimization of the "weighted" sum of the squares of the errors in magnitude. This method is applicable to both minimum and non-minimum phase systems. (auth)

30901 (HW-76692) GENORO, A GENERAL DATA FITTING AND LINEAR FUNCTIONAL EVALUATION COMPUTER CODE FOR THE IBM-7090. C. A. Oster (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1963. Contract AT(45-1)-1350. 62p.

The GENORO computer code permits: the determination of the best fitting functional for a given set of data points, the evaluation of the obtained functional, or the evaluation of any other functional of the same form. The data points may be any n arbitrary points in a δ-dimensional space. Two types of functionals may be considered. A functional of one type must be some linear combination of a set of $m \leq n$ linearly independent functions, while functions of the second type are such that their logarithm satisfies this linearity condition. The evaluation may be performed at any set of arbitrary points. (auth)

30902 (TID-17375) DESIGN OF A PATTERN RECOGNITION DIGITAL COMPUTER. PART I. GENERAL INTRODUCTION. Report No. 125. B. H. McCormick (Illinois. Univ., Urbana. Digital Computer Lab.). Oct. 1, 1962. Contract AT(11-1)-1018. 31p.

Uses, requirements, operation, design, and possible interim stages in the realization of a computer for visual pattern recognition are discussed. A schematic of a pattern recognition computer is included. (D.C.W.)

30903 (TID-19018) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. ILLIAC II SYSTEM PROGRAMMING AND OPERATION. PART III. CIRCUIT RESEARCH PROGRAM. PART IV. SWITCHING THEORY. PART V. DATA REDUCTION METHODS. PART VI. IBM 7090-1401 SYSTEM. PART VII. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). May 1963. Contract AT(11-1)-415. 47p.

Developments in the high-speed computer program, ILLIAC II system programming and operation, and data reduction methods are summarized. Circuit research dealt with avalanche breakdown, laser logic, and transmission lines. A study of transmission line amplifier performance as a function of the tolerances on the positive terminating resistances, on the negative resistance of the tunnel diodes, and on inflection point position showed that the tolerances essentially affect the lower cutoff frequency. A new mechanism was proposed to explain the very different avalanche breakdown curves of alloyed and diffused transistors: the explanation compares essentially the RI field in the base to the built-in field. The original Miller theory of breakdown seems to hold when such effects are taken into account. A study of laser logic was begun. It was theoretically shown that the intensity of a narrow, well-collimated light beam can be modulated by a low voltage, low power electric signal. Five new routines were added to the 7090, and 40 problem specifications (described) were submitted for the IBM-7090. Information on the reliability and utilization of the IBM-1401 and IBM-7090 is included. (D.C.W.)

30904 ON THE YVON APPROXIMATION METHOD. [PART] IV. H. A. Kellner and Th. Nonnenmacher (Technische Hochschule, Karlsruhe, Ger.). Atomkernenergie, 8: 201-3(June 1963). (In German)

Considering the fact that eigenvalues of the Boltzmann equation in plane geometry are known, the distribution of the roots of the characteristic polynomials in Yvon's method of approximation is discussed. These polynomials are given and their roots are tabulated up to the third approximation ($P_{3,3}$) for $c \geq 1$ (absorber). Further, it was investigated which order N of approximation is required to ensure that the asymptotic root exceeds 1. The values of c_{grenz} are tabulated up to the $P_{10,10}$ approximation, and they are compared with those of the spherical-harmonics approximation. The latter is slightly better in this respect. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

Refer also to abstracts 29957, 30188, 30189, 30190, and 31771.

30905 (ARF-B198-42) IMPROVED ZIRCONIUM ALLOYS. Quarterly Report, April 1, 1963–June 30, 1963. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-578. 16p. (EURAEC-713)

The oxidation of the following zirconium alloys in water at 680°F is reported: Zircaloy-2, Zr–Cr–Te, Zr–Nb–Te, Zr–Sn–Te, Zr–Sn–Ge, Zr–Sb–Ge, Zr–Sb–Te, and Zr–Sb–Nb. The tensile properties of Zircaloy-2, Zr–Cr–Te, and Zr–Nb–Te alloys at room temperature and 680° are given. (N.W.R.)

30906 (BMI-1633) FABRICATION AND PROPERTIES OF HOT-PRESSED URANIUM MONONITRIDE. Edward O. Speidel and Donald L. Keller (Battelle Memorial Inst., Columbus, Ohio). May 30, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 67p. (EURAEC-706)

Dense UN specimens for property tests were fabricated primarily by an isostatic hot-pressing technique in which consolidated powder sealed in a refractory metal container was subjected to a 10,000-psi external gas pressure at 1480 to 1540°C for 3 to 4 hr. The thermal conductivity of uranium mononitride increased from 0.04 cal/(cm)(sec)(°C) at 200°C to 0.06 cal/(sec)(cm^2)(°C) at 1000°C, which by an integrated thermal-conductivity criterion, makes it some eight times more effective than UO_2 in transferring heat. Thermal-expansion coefficients of 9.0×10^{-6} per °C and 9.9×10^{-6} per °C over the ranges 20 to 800°C and 20 to 1600°C, respectively, were measured. UN retained about 80% of its room-temperature hardness at 1100°C. Above this temperature, the hardness dropped rapidly with increasing temperature. The specific heat is cal per g mole can be conveniently described by the equation $C_p = 13.32 + 1.19 \times 10^{-3}\ T - 2.10 \times 10^{5}\ T^{-2}$ over the range 273 to 1423°K. Electrical conductivity dropped with increasing temperature, a metallic characteristic. Anomalies were noted in attempts to measure the hydrogen solubility and the resistance to water corrosion. UN is apparently not attacked by NaK within 1500 hr at temperatures up to 480°C. (auth)

30907 (CONF-50-2) PLUTONIUM-BEARING GLASS FOR NUCLEAR APPLICATIONS. L. V. Jones, K. D. Phipps, P. A. Tucker, and L. J. Wittenberg (Mound Lab., Miamisburg, Ohio). [1961]. Contract AT(33-1)-Gen-53. 26p.

From American Ceramic Society Annual Meeting, Pittsburgh, Apr.-May 1963.

Silicate glasses were prepared which contain plutonium oxide as a constituent. Incorporation of the plutonium oxide into a silicate system effectively reduces the hazards normally associated with the handling of plutonium oxide. The plutonium-bearing glasses have possible application as fuels for chemonuclear, testing, and power reactors. Laboratory size batches were prepared by dissolving up to 20 wt.% PuO_2 into parent glass formulations. The plutonium-bearing glass can be formed into various configurations such as fibers, microspheres, and rods. The properties of the glass were investigated by chemical and physical techniques. The plutonium-bearing glasses make excellent standard alpha sources because of their contamination-free nature and excellent chemical durability. Fluoride glasses containing PuF_4 produce neutrons by the (α,n) reaction and are useful as low-level neutron sources. (auth)

30908 (DP-802) ELECTROWINNING CERIUM METAL. John A. Porter and LeVerne P. Fernandez (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). May 1963. Contract AT(07-2)-1. 24p.

Cerium metal was produced by electrolysis of molten $LiF–BaF_2–CeF_3$ systems with either CeO_2 or CeF_3 as feed. Conditions favoring efficient cell operation were determined, and a sequence of probable cell reactions was developed. In general, operation with CeO_2 as feed was much more satisfactory than with the pure fluoride system. (auth)

30909 (GA-2881) PREPARATION OF (Th,U)C_2 FUEL PARTICLES FOR THE HTGR. Walter V. Goeddel and Howard E. Shoemaker (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Nov. 12, 1962. Contract AT(04-3)-314. 20p.

A process that was developed for the preparation of particles of thorium–uranium dicarbide is described. Granulated particles composed of powdered UO_2, ThO_2, and carbon were suspended in a bed of graphite flour and heated to convert the oxides to dicarbides. The particles were then melted to densify and spheroidize them, the graphite flour keeping them separated so that they would not flow together. (auth)

30910 (GEMP-24A) HIGH-TEMPERATURE MATERIALS PROGRAM. Progress Report No. 24, Part A. (General Electric Co. Advanced Technology Services, Cincinnati). June 28, 1963. Contract AT(40-1)-2847. 28p.

The physical and mechanical properties of beryllium oxides are studied with respect to the effects of radiation, purity, glass additives, grain size, density, and porosity at various temperatures and irradiation dosages. Specimens irradiated at 800 to 1000°C to 10^{21} nvt exhibited volume expansion of the order of 1%. Expansion generally followed a trend of smaller expansion for smaller grain sizes. Microscopic examinations indicated a progressive increase in the size and number of helium bubbles with increasing grain size; very few bubbles occurred in 5-micron grain-size specimens under these irradiation conditions. (N.W.R.)

30911 (NCSC-2663-12) URANIUM INTERSTITIAL PHASES. Progress Report, May 1963. Robert F. Stoops and John V. Hamme (North Carolina State Coll., Raleigh). Work performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-2663. 19p. (EURAEC-723)

The U–C–O ternary system diagram is given expressing the phases reacted at 1800°C in vacuums or inert atmospheres and furnace cooled. A U(C,O) single phase area exists. The limit of substitutional solid solution of oxygen atoms for carbon atoms in UC is 12.5 at. % which means that only 25% of the carbon atoms in UC can be replaced by oxygen atoms. The oxygen saturated UC phase, $U(C_{0.75}O_{0.25})$, has a lattice parameter of 4.953 ± 0.001A. The carbon monoxide partial pressures in equilibrium with this

phase were determined for temperatures between 1705 and 1855°C. Cursory tests indicate that $U(C_{0.75}O_{0.25})$ may have significant advantages as a nuclear fuel material. (auth)

30912 (NMI-2118) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission for the Month of May 1963. (Nuclear Metals, Inc., Concord, Mass.). July 12, 1963. Contract AT(30-1)-2784. 29p.

Zone refining of a beryllium crystal containing iron and silicon impurity additions was completed. Final refinements of the compression test method were made. Extrusion techniques for Re–Ta–W and Ru–Ta–W alloys were developed. Finishing of niobium–rhenium alloys by rolling was accomplished. Electron and light microscopy examinations were made on copper–uranium alloys in order to determine the particle size, shape, and density as a function of thermal history. Splat-cooled uranium intended to contain about 700 to 800 ppm carbon was produced and consolidated by hot compaction at 600°C. An extensive metallographic examination of extruded and drawn tungsten tubing was made and evaluated. (N.W.R.)

30913 (NP-12972) PHASE RELATIONSHIPS OF MOLYBDENUM, NIOBIUM AND TUNGSTEN BORIDES, CARBIDES AND SILICIDES: AN ANNOTATED BIBLIOGRAPHY. Jack B. Goldmann (Lockheed Missile Space Co., Sunnyvale, Calif.). Dec. 1962. 87p. (SB-63-9)

An annotated bibliography is presented which emphasizes phase relations and fabrication parameters, as evidenced in the physical properties and powder metallurgy, of refractory Mo, Nb, and W compounds with B, C, and Si. The period, 1955–1962, yielded the majority of the references. The resources of Lockheed Missiles and Space Company Technical Information Center were utilized in the preparation and compilation of this survey. (auth)

30914 (NP-12973) STRENGTHENING OF CHROMIUM–MAGNESIA COMPOSITES. Interim Report No. 2, April 1, 1963–May 31, 1963. G. C. Reed (Bendix Corp. Bendix Products Aerospace Div., South Bend, Ind.). June 14, 1963. Contract N600(19)59647. 16p.

Extrusions are prepared for evaluation of several compositional and processing variables aimed at improving ductility. Impact and tensile properties exhibited by these extrusions are reported. Pertinent chemical analyses are given. The best improvements are obtained by reducing the magnesia content. The compound containing 3 wt % magnesia exhibited 45% tensile elongation at room temperature. It was decided that these results warranted further study before starting the alloy phase of this program. Four billets representing other low magnesia percentages are prepared for this purpose. (auth)

30915 (NP-12974) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. Patricia B. Plate, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). June 1963. 64p.

A listing of selected documents and journal articles in abstracted form for June 1963 on high-strength alloys, light metals, nonmetallics, refractory metals, coatings, applications, and composites is presented. Author, subject, and DMIC numerical indexes are included. (N.W.R.)

30916 (NUMEC-P-54) DEVELOPMENT OF PLUTONIUM-BEARING FUEL MATERIALS. Monthly Progress Letter, January 1963. Karl H. Puechl (Nuclear Materials and Equipment Corp., Apollo, Penna.). Feb. 5, 1963. Contract AT(30-1)-2389. 6p.

A set of irradiation specimens and the combination coolant flow directors-capsule holders are ready for shipment to the GETR. Outfitting of the alpha boxes for the hot cell and hot metallography cell is continuing. An alpha box which will house equipment for chemical separations and fuel burnup analysis was designed for the Junior Cave. Fuel pellets were fabricated so that corrosion studies under various water chemistry conditions can be initiated. Duplex pellets consisting of UO_2–PO_2 and various inert materials were sintered to ascertain the degree of reaction between constituents. The PuO_2 preparation studies were extended to include the peroxide route. Preliminary results indicate that the product PuO_2 powder has characteristics similar to powder produced by the oxalate route, however, sinterability trials were not made. (N.W.R.)

30917 (SC-4920(M)) ADVANCED TECHNOLOGY SYMPOSIUM. Proceedings of the Third Annual Symposium held at University of New Mexico, November 2-3, 1962. (American Society of Mechanical Engineers. New Mexico Section). Contract AT(29-1)-789. 94p.

Five papers and 12 summaries of papers given at the Advanced Technology Symposium are presented. Separate abstracts were prepared for 5 papers and one was previously abstracted for NSA. (M.C.G.)

30918 (SC-4920(M)(p.25-40)) NUCLEAR RAMJET REACTORS. Carl E. Walter (California. Univ., Livermore. Lawrence Radiation Lab.).

Material and design considerations for a nuclear ramjet reactor are discussed. It is shown that the reactor development philosophy led to the construction of extensive facilities capable of delivering very large flow rates of heated air. A description of the Tory II-A scale-model reactor, which was successfully tested, is also presented. The Tory II-C system is discussed. (M.C.G.)

30919 (SC-4920(M)(p.41-62)) RADIATION EFFECTS ON METAL MATERIALS. R. G. Berggren (Oak Ridge National Lab., Tenn.).

The problems of radiation effects in reactor structural metals and steels are considered. Fundamentals of radiation effects are listed. Observed property changes in metals and post-irradiation recovery are discussed. It is shown that the mechanical properties of metals can be altered considerably by exposure to reactor radiations. These changes appeared to be complex functions of a number of parameters. (M.C.G.)

30920 (SC-4920(M)(p.63-72)) RADIATION EFFECTS ON NONMETALLIC MATERIALS. George W. Arnold (Sandia Corp., Albuquerque, N. Mex.).

Types of radiation sources for use in studies of radiation effects on nonmetallic materials are described. Energy-loss processes and physical property changes are discussed. (M.C.G.)

30921 (SC-4920(M)(p.73-6)) METALWORKING USING ELECTRON-BEAM TECHNIQUES. F. R. Schollhammer (Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn.).

Progress on electron-beam welding and cutting applications that can be employed in the metal-working industry in a range of applications from microelectronics to the welding of turbine wheels is reported. Specific applications and techniques used in the construction and repair of given production components are described. The advantages of electron-beam techniques are discussed. Examples of methods are given. (M.C.G.)

30922 (SC-4920(M)(p.77-9)) FIELD ION MICROSCOPY. Erwin W. Mueller (Pennsylvania State Univ., University Park).

The use of field ion microscopy to observe directly the atomic structure of refractory metals is discussed. (M.C.G.)

30923 NUCLEAR METALLURGY. VOLUME VIII. A Symposium on Selection of Materials for Gas-Cooled and Water-Cooled Reactors, Fall Meeting of the Metallurgical Society, AIME, New York, October 31, 1962. IMD Special Report Series No. 11. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser. No. 11, 1-208(1962). New York, Metallurgical Society of American Institute of Mining, Metallurgical, and Petroleum Engineers, 1962. 208p. $8.00.

Eight papers of a review nature are presented on the development and properties of materials for the following reactor types: gas-cooled, water-cooled, pressurized-water, boiling, and superheat. Separate abstracts were prepared for seven of the papers; the other paper was previously abstracted in NSA. (D.L.C.)

30924 REVIEW OF MATERIALS FOR GAS-COOLED REACTORS. G. Brown and R. W. Nichols (United Kingdom Atomic Energy Authority, Warrington and Culcheth, Eng.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 11, 3-31(1962).

A review is presented of the various aspects of reactor materials important to the design of the Calder Hall type graphite moderated reactor and of the Windscale Advanced Gas-cooled Reactor. Some factors leading to the selection of CO_2 as a coolant are described, and its specification is given. The principal problems associated with the use of a graphite moderator are outlined. Following discussion of the influence of design on the initial requirements of density, strength, and permeability to gases, the effects of irradiation are discussed. Neutron irradiation causes accumulation of stored energy in the graphite which could be hazardous if released at an excessive rate during transient conditions. However, selection of a minimum graphite operating temperature in relation to the flux rating of a particular design ensures that the maximum possible energy release rate will not exceed a critical value during the lifetime of the reactor. Neutron bombardment also causes dimensional changes in the graphite, and curves showing the expected trends of behavior are presented. Design measures to ensure that the graphite structure will continue to behave satisfactorily in the presence of gross dimensional changes are described, and mention is made of the problems arising from differential growth effects. While thermal reaction of graphite with CO_2 is not a problem below 600°C, attack of the graphite can occur in the reactor because of radiolytic decomposition of CO_2, the weight loss increasing with higher neutron and gamma flux ratings and increased gas pressures. In the A.G.R., controlled additions of CO will be necessary to reduce the rate of attack. Factors influencing the continual safe working of a steel pressure vessel are outlined. Particular attention is given to the safeguards used to avoid brittle fracture and to the effects of irradiation. Data on high temperature properties and fatigue behavior are summarized. The oxidation behavior of various pressure circuit materials in CO_2 is described, the data indicating that these materials will be satisfactory at the conditions of service in the Windscale A.G.R. Finally, a summary is given of the measures taken in the operating reactors to monitor for changes in properties of the steel and graphite. (auth)

30925 MATERIALS SELECTION FOR GAS-COOLED REACTORS IN FRANCE. R. Caillat and J. Stohr (Centre d'Etudes Nucléaires, Saclay, France). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 11, 33-48(1962).

The study of materials of construction for gas-cooled reactors was started rather early in France when planning the EL.2 reactor just before 1950. In the construction of the G.1 and then the G.2 and G.3 reactors, much more difficult problems occurred. A magnesium alloy which appears to be particularly suitable for canning in this type of reactor is a Mg–Zr alloy containing 0.6 wt % zirconium. The data obtained in using it are presented. On the subject of the fuel materials, the results obtained in testing a large number of uranium alloys containing small quantities of low capture cross section additives are reported. Some of these alloys can be used at burn up rates as high as 10,000 Mwd/t. In the heavy water moderated gas-cooled reactor EL.4 (the coolant is CO_2 at 60 kg. cm^{-2}), more important problems arise due to the high temperature of the gas coolant which is almost 500°C. The performances of zirconium as a material for pressure tubes, stainless steel as a canning material, zirconium and magnesium alloys for thermal insulation devices, and finally low-alloy steels for heat exchangers and piping are described. During the investigations in connection with the EL.4 project, a new nuclear material was prepared and developed; this material, sintered magnesium, in addition to having the low capture cross section of magnesium, has mechanical properties at high temperature similar to those of sintered aluminum. (auth)

30926 THE EXPERIMENTAL GAS-COOLED REACTOR. W. D. Manly and J. H. Coobs (Oak Ridge National Lab., Tenn.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 11, 49-82 (1962).

The Experimental Gas-Cooled Reactor, designated EGCR, is currently being constructed in Oak Ridge, Tennessee, under the direction of the U. S. Atomic Energy Commission. The reactor will be a dual purpose plant in that it has been designed to provide for both power demonstration and experimental testing. It is a helium-cooled, graphite-moderated reactor, using high performance fuel elements with stainless steel clad, slightly enriched bulk UO_2 fuel. The history of the development of the EGCR is reviewed, and pertinent design and operating parameters that affect materials selection will be presented. The design and development activities in support of the EGCR have provided answers for most of the original design problems. The development program has included the following studies: selection of helium as the coolant; compatibility of structural steels and stainless steel cladding materials with helium contaminated with oxidizing impurities; irradiation testing of bulk UO_2 to explore the effect of shape, purity, and density on the fission-gas release and structural stability of UO_2; the effect of environment and neutron damage on the mechanical properties of stainless steels; and other similar materials investigations. Dissimilar-metal welding studies were also conducted in order to arrive at a satisfactory joint design for the SA-212, Grade B, pressure vessel steel and type 304 stainless steel piping. The compatibility of various control rod materials was examined to arrive at a suitable control rod for the EGCR. The solution of these development problems has provided the necessary information for the procurement of the large graphite columns, fuel elements, control rods, and other components. The present status of the

materials development program is presented, and the effect on future clad reactor designs is discussed. (auth)

30927 FUEL ELEMENTS FOR U. K. GAS-COOLED REACTORS. G. B. Greenough (United Kingdom Atomic Energy Authority, Springfield Works, Eng.) and P. Murray. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 11, 83-107(1962).

Features of the behavior of fuel elements relevant to the current U.K. Gas Cooled Reactor Program are discussed. In the case of uranium-magnox fuel elements, attention is drawn to the importance of the mechanical properties of the magnesium alloys, such as the effect of grain size on ductility, creep strength in the fuel element supports, and the relevance of fatigue properties to reactor power changes. Data are also presented showing the effect of small amounts of iron and aluminum on the irradiation growth and irradiation swelling behavior of beta quenched uranium metal. The main features influencing the selection of UO_2 as the fuel and 20 Cr/25 Ni/1 Nb as the canning alloy for the Windscale Advanced Gas Cooled Reactor are also noted. The importance of obtaining minimal fission gas release from the fuel is emphasized for the gas cooled case and irradiation data presented up to 10,000 Mwd/t. Preliminary results on higher burn-up UO_2-stainless steel fuel elements up to 50,000 Mwd/t are also discussed in this context. Interaction effects between the UO_2 pellets and the stainless steel cans leading to ratchetting are also discussed. For high temperature reactors, dispersions of carbide in graphite and of UO_2 in BeO are the relevant fuels and the major problem in these systems is the development of fuels and fuel elements which retain fission gases and fission products at high temperatures. The current research and development work, including irradiation behavior, being carried out in these systems, is described. (auth)

30928 MATERIALS SELECTION FOR THE YANKEE AND SUBSEQUENT PWR'S. L. B. Kramer (Westinghouse Electric Corp., Pittsburgh). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 11, 129-61(1962).

The choice of core and plant materials for those plants designed by the Westinghouse Atomic Power Division is described. The application, in terms of components, the specifications used for the materials, particularly where these specifications differed from accepted specifications, and certain problems associated with their use are given. (auth)

30929 MATERIALS FOR DRESDEN AND OTHER BOILING WATER REACTORS. S. Naymark (General Electric Co., San Jose, Calif.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 11, 163-89(1962).

A review is presented of boiling water reactor plant materials knowledge, gained by both operating experience and development testing. Materials covered include primarily those in the reactor and remainder of plant that see primary water/steam. Results to date indicate that materials are available which can be specified to build plants meeting current design requirements. Predictions on material performance to end of life, and on material limits which might allow reactor plants to be pushed beyond present designs, require a continuing development and testing effort. (auth)

30930 MATERIALS FOR SUPERHEAT REACTORS. C. N. Spalaris (General Electric Co., San Jose, Calif.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 11, 191-208(1962).

The environmental conditions anticipated in nuclear plants are in many respects similar to those found in conventional plants but with the addition of three very important factors. These factors are (a) the presence of neutron flux, (b) the high oxygen content in steam coolant, and (c) mode of plant operation. All these factors are expected to have significant effects upon material behavior in long time service at high pressures and temperatures, but these effects are not known at the present time. The available information which can be applied directly to material selection in nuclear superheat systems is very limited; therefore, new data must be developed which can be used as a basis for selecting materials for development and eventual use in nuclear superheat plants. Corrosion, metallurgical, and fabrication requirements of alloys ear-marked for use in high temperature nuclear environment are discussed. In addition to the alloys that must be used for fuel cladding and other core components, the selection of fissionable material must be such as to provide maximum service performance reliability. Information regarding corrosion behavior of alloys used for fuel clad in recent reactor and laboratory experiments is presented. The chemical stability of uranium dioxide in nuclear superheat steam was studied both in reactor and laboratory experiments; the results are both presented and discussed. (auth)

30931 THE PREDICTION OF OXIDATION RATES OF CARBONACEOUS MATERIALS FROM PLASMA ARC TESTS. J. K. Haviland and J. E. Medford (Chance Vought Corp., Dallas). 41p. (CONF-73-2).

From Sixth Biennial Conference on Carbon, Univ. of Pittsburgh, June 1963.

A series of stagnation point plasma arc tests on specimens of carbonaceous material was examined to find out whether the loss of mass could be explained in terms of oxidation of the carbon. Up to a surface temperature of 4000°F, it was found that it could be predicted in terms of the rate of diffusion of oxygen through the boundary layer, computed by Lewis analogy from the known heat flux and driving enthalpy. Best results were obtained by assuming that carbon monoxide was formed and by using the net heat flux corrected for hot wall and transpiration cooling effects. One series of specimens exhibited marked oxidation resistance, and here the loss rate conformed to the half-order Arrhenius equation, in which Lewis analogy was again used to compute the partial pressure of oxygen near the wall. In this case it was possible to compute the reaction rate coefficient of oxidation for the material. Above 4000°F, it was found that additional mass loss was caused by spalling. This was a strong function of temperature, and could be correlated by an equation of the Arrhenius form, although insufficient data were available to determine pressure effects. It is concluded that sufficient information can be obtained from plasma tests to compute the oxidation and spalling rates of a carbonaceous material on a re-entry vehicle. (auth)

30932 REPORT OF THE NATIONAL CHEMICAL LABORATORY, 1962. Report of the Steering Committee and Report of the Director of the National Laboratory for 1962. (Gt. Brit. Dept. of Scientific and Industrial Research). 1963. 94p. 6s. 6d. (HMSO).

Descriptions of work and progress made by groups on new materials, metal extraction, inorganic materials, and corrosion of metals, and isotope applications are presented. (P.C.H.)

30933 IMPROVEMENTS IN AND RELATING TO CARBONACEOUS COMPOSITIONS. Paul Charles Johnson (to

Union Carbide Corp.). British Patent 926,073. May 15, 1963. Filed June 17, 1961.

An electrically conductive cement capable of adhering to carbon and graphite surfaces is patented. The cement consists of a mixture of finely divided graphite and/or graphitizable carbonaceous particles and a thermosetting resinous binder, which is a furfuraldehyde-ketone condensation product composed of a mixture of partially hydrogenated mono- and di-furfuryl ketones. An acidic polymerization catalyst may be added to the mixture. The cemented joint should be heated to 125°C as soon as possible after assembly and held for one hour to obtain maximum strength. Information on the preferred ratio of constituents in the cement, various catalysts and the curing time at various temperatures for each catalyst, and the strength of the cement joints is presented. (M.P.G.)

30934 SHIELDING MATERIAL AND PROCESS FOR THE PRODUCTION THEREOF FROM BORATES OF LEAD, CALCIUM, BARIUM, MAGNESIUM, CADMIUM OR ZINC. (to Johns-Manville Corp.). British Patent 926,292. May 15, 1963. Priority date Dec. 31, 1958, United States.

A hydrated borate material for structural shielding against neutrons is patented. The material consists of reinforcing fiber and a self-bonding water-insoluble gel reaction product. The hydrated borate gel precipitate is prepared by combining, in aqueous solution, borax and a soluble salt of Pb, Ca, Ba, Mg, Cd, or Zn at a temperature of 60 to 210°F. The solution contains, on an oxide basis, ~1 to 2 mols of B_2O_3 for each mole of divalent metal oxide and admixing reinforcing fiber. The gel reaction product may also be prepared from a soluble salt of an organic or mineral acid. The shielding material may be moulded or shaped into self-supporting structural shapes or may be used as a cohesive self-bonding cement. (M.P.G.)

30935 ZIRCONIUM DIOXIDE RECOVERY. Edgel P. Stambaugh and Raymond A. Foos (to National Distillers and Chemical Corp.). U. S. Patent 3,090,670. May 21, 1963. Filed June 18, 1959.

A method for recovering purified, finely divided ZrO_2 and/or HfO_2 from acidic solutions of these metals is patented. An aqueous acidic solution of Zr is heated to a temperature of at least 140°C at a pressure of at least 50 psi for 2 to 60 min. The solution must contain an acid such as hydrochloric or sulfuric. The resulting ZrO_2 product precipitates from the solution. The average particle size of the ZrO_2 was found to be usually ~1 to 5 μ. If the Zr-containing feed solution contains metallic impurities, the ZrO_2 product has a decidedly lower content of these impurities. (Hf is not considered to be a metallic impurity.) (M.P.G.)

Corrosion

30936 (GEAP-4020) EROSION FLOW TESTING OF PURPOSELY DEFECTED STAINLESS STEEL CLAD COMPACTED UO_2 POWDER FUEL. J. W. Lingafelter, E. A. Lees, and R. J. Seely (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Feb. 1962. Contract AT(04-3)-361. 58p.

Compacted UO_2 powder specimens with purposely defected stainless steel cladding were erosion flow tested under simulated boiling-water reactor operating conditions, excluding neutron flux. The type of clad defects were 0.020-inch wide slits, completely through the clad, varying in length from 0.25 to 1 inch. Maximum erosion flow test exposure was 6000 hours in 7 ft/sec, 536°F flowing water. The results of post test examination indicated that defected stainless-clad swaged fuel with UO_2 densities greater than 90% T.D. is comparable to pellet type fuel with respect to erosion resistance. Within the test parameters, the stresses and imperfections introduced into the stainless cladding as a result of swaging did not adversely affect the corrosion characteristics of stainless steel in a boiling water reactor coolant environment. As a result of the test data, two swaged fuel rods containing 0.50-inch long slits were inserted into the VBWR reactor. The defected rods are performing satisfactorily after accumulating 1000 Mwd/t exposure, with activity due to fission gas release below 20 μc/sec. (auth)

30937 (NP-12968) EXPERIMENTAL STUDY OF FACTORS CONTROLLING THE EFFECTIVENESS OF HIGH-TEMPERATURE PROTECTIVE COATINGS FOR TUNGSTEN. Quarterly Progress Report No. 3, November 15, 1962–February 15, 1963. C. D. Dickinson and L. L. Seigle (General Telephone and Electrics Labs. Inc., Bayside, N. Y.). Mar. 15, 1963. Contract AF33(657)-8787. 81p. (TR-63-461.10)

Processes governing the efficacy of high-temperature protective coatings for W, interdiffusion in ternary oxygen-metal-metal systems and breakaway during oxide film growth, are investigated to determine the oxidation behavior of binary alloys and the influence of substrate mechanical properties on the growth characteristics of the oxide films. Experiments on oxidation kinetics and the microstructural and quantitative identification of the layers formed were conducted on seven systems. Experiments on the effect of N_2 on the diffusion processes that govern the growth of oxides in the Zr–Th–O system are described. The results obtained in the W–Hf–O, W–Hf–Re–O, Zr–N–O, and ZrN–ThN–O systems and the Sn–Al–Cr and Sn–Al–La systems are given. Preliminary experiments on the Zr–Y–O and Hf–Y–O systems are described. (auth)

30938 (NP-12971) HIGH TEMPERATURE OXIDATION PROTECTIVE COATINGS FOR VANADIUM-BASE ALLOYS. Bimonthly Report No. 4, March 13, 1963–May 12, 1963. Larry I. Kane, John J. Rausch, and F. C. Holtz (Illinois Inst. of Tech., Chicago. IIT Research Inst.). June 7, 1963. Contract N600(19)-59182. 22p.

The influence of thermal history for a standardized pack siliconizing process was established for 0.020 to 0.030 inch sheet of the V–60 wt % Nb–1 wt % Ti alloy. Studies of coating thickness as a function of siliconizing time over the temperature range of 2000 to 2200°F were made. Coating thickness of 2.25 to 2.75 mils appears to offer optimum oxidation protection based on static air oxidation tests at 2200°F; specimens were exposed for more than 500 hours without evidence of failure. Thick coatings, i.e., 4 mils or greater, suffer gross delamination or severe cracking during elastic bending of sheet materials which results in a loss of protective capability. The thicker coatings also appear to behave poorly in high temperature, thermal cycle oxidation tests in an oxygen-hydrogen torch. (auth)

30939 (SY-5396-R4) SPUR POWER SYSTEM. Quarterly Progress Report for Period Ending March 31, 1963. F. B. Wallace and R. W. Heldenbrand (Garrett Corp. AiResearch Mfg. Div. of Arizona, Phoenix). Apr. 15, 1963. Contract AF33(657)-8954. 72p.

Work in materials development was devoted to mechanical testing of Mo–Ti alloys, Nb–Zr alloys, and braze alloys in high-temperature Li and K. Other tests and developmental work on bearings, turbines, generators, heat transfer, and reactor loops are reported. (J.R.D.)

30940 CORROSION OF THE MATERIALS USED IN NUCLEAR TECHNOLOGY. C. Motoc (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 79-98(1963). (In Rumanian)

Corrosion of materials exposed to nuclear radiation is aggravated by the strong oxidizing agents formed during the exposure. Exact knowledge of the corrosion mechanism is especially important under actual operating conditions of high-temperature gas-cooled or water-cooled reactors. The impurities in the coolant may affect the corrosion of fuel element components or the structural materials; the type of prevalent process, such as homogeneous or intergranular corrosion, may affect strongly the service life. Presence of water vapors aggravates the oxidation of the metals exposed to radiation, as a result of the simultaneous action of the oxidizing medium and the radiation-generated defects. Protective oxide layers were found useful in many cases. The resistance of metals against CO_2, a much used reactor coolant, is well studied. The usefulness of a given metal depends greatly on the fact whether the corrosion rate follows a linear, parabolic, or cubic law. Aqueous solutions contain radiation-generated oxidation or reduction products; dissolved N was found to be especially harmful. The corrosion rate of metallic U is high in He, Ar, Co, and CO_2 because of the high moisture content of these gases; the material necessitates the use of claddings, or alloys must be employed. The resistance of Zr is enhanced by adding small amounts of alloying metals. The complex behavior of stainless steels is reviewed. (44 references.) (TTT)

30941 ZIRCONIUM ALLOY CORROSION IN HIGH-TEMPERATURE HALIDE SOLUTIONS. W. E. Berry, E. L. White, and F. W. Fink (Battelle Memorial Inst., Columbus, Ohio). Corrosion, 19: 253t-9t(July 1963).

The corrosion behavior of Zircaloy-4 was studied in 680°F halide solutions adjusted to pH 10.5 with LiOH or NH_4OH. No accelerated corrosion was observed after 56 days' exposure to 0.01 M solutions of LiCl, LiI, NH_4Cl or NH_4I, with or without Fe_3O_4 suspensions in the solutions. Severe attack occurred in Fe_3O_4-free 0.01 M LiF and NH_4F solutions. Although large quantities of Fe_3O_4 in suspension decreased attack by decreasing the fluoride concentration of the solution, thin surface deposits of Fe_3O_4 on the Zircaloy-4 surface did not appear to increase or retard attack in the 0.01 M fluoride solutions. No unusual corrosion occurred in 0.001 M LiF or 0.0001 M NH_4F solutions. (auth)

30942 ON THE PROBLEM OF METALLIC URANIUM OXIDATION AT HIGH-TEMPERATURES. A. F. Bessonov and V. G. Vlasov (Kirov Urals Polytechnic Inst., USSR). Fiz. Metal. i Metalloved., 15: 477-9(Mar. 1963). (In Russian)

The oxidation of 99.8% pure U by CO_2 in a high-vacuum installation at 900 to 1000°C was investigated, and isotherms were constructed for up to 1000°C temperature and 420 mm Hg CO_2 pressure. A decreased oxidation observed at 900 to 1000°C was explained by increased uranium dioxide density at this temperature. (R.V.J.)

30943 SURFACE TEMPERATURE OF Nb AND Zr DURING OXIDATION. B. N. Revyakin and I. I. Korobkov (Moscow Inst. of Engineering Physics). Fiz. Metal. i Metalloved., 15: 624-5(Apr. 1963). (In Russian)

Direct measurements were made of the surface temperature of commercial-grade Nb during oxidation in air at 650, 795, and 900°C and of Zr at 900°C. The measurement accuracy was ±3°C. Within 5 to 10 sec after Nb specimens were introduced into a furnace with a temperature of 650, 795, or 900°C, the surface temperature of the specimens rapidly rose 10, 80, or 110°C, respectively, above the ambient temperature and after a few seconds dropped back. In the case of Zr, the increase was 115°C; it occurred after a 20-sec heating and lasted a considerably shorter time than in Nb, probably because of the high protective properties of Zr oxides. The magnitude of overheating is stated to depend on many factors, such as the oxidation rate, heat of oxide formation, area-to-mass ratio of the specimen, specific heat, heat conductivity, and condition of the specimen surface, all of which must be considered in studying the kinetics of oxidation of active metals. (AID Press, (2:14))

30944 ION ENGINE RELIABILITY AS AFFECTED BY CORROSION OF MATERIALS. P. M. Winslow (Hughes Aircraft Co., Culver City, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63032, 13p. (CONF-10-17)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Detailed corrosion information on 50- and 500-hour exposure tests of a number of ion engine structural metals in both cesium vapor and liquid is presented. The structural metals tested for corrosion included the 300 series stainless steels, Sicromo, and Inconel, as well as a titanium–vanadium alloy. Tests on tantalum, tungsten, and a possible oxygen getter alloy were also run. Important aspects of the impurities study are the effects of oxygen in cesium on corrosion as well as on potential degradation of the ionizer. The most formidable problems associated with oxygen relate to the measurement of the oxygen level in cesium. Analytical methods used for oxygen in other alkali metals have not proved entirely satisfactory for cesium. (auth)

30945 CORROSION PROTECTION OF ALUMINUM. Robert S. Dalrymple and William B. Nelson (to U. S. Atomic Energy Commission). U. S. Patent 3,096,220. July 2, 1963.

A process for protecting aluminum-base materials against corrosion by immersion in 0.5 to 3-wt. % chromic acid solutions having a pH of below 2 at 160 to 180°C in an autoclave is described. (AEC)

Fabrication

Refer also to abstracts 29892, 30635, and 30957.

30946 (CONF-50-5) A STUDY OF EXTRUSION PROPERTIES OF NON-CLAY OXIDES. J. F. White and A. L. Clavel (General Electric Co. Advanced Technology Services, Cincinnati). Mar. 28, 1963. Revised Apr. 9, 1963. Contract AT(40-1)-2847. 19p. (TM-63-1-6)

From American Ceramic Society Annual Meeting, Pittsburgh, Apr.-May 1963.

The preparation of plastic dispersion masses of non-clay oxides using different organic plasticizers was studied using an extrusion method for measuring the flow characteristics. These studies show that the flow characteristics are: for a given powder, dependent on the kind and amount of organic plasticizer used; and for a given plasticizer, dependent on the kind, amount, and grain size of the oxide powder. Thus, these non-clay powders can be prepared with flow characteristics similar to a plastic clay. It was found that under certain conditions, the oxide powder made plastic with a minimum amount of organic plasticizer

causes the resulting mass to behave as a Bingham solid at relatively high rates of applying the pressure necessary for flow, but this same mass will be dilatant if the rate is low. A model is proposed for the non-clay oxide plastic dispersion mass using the concept of organic matter adherence to the oxide particle. This model is used in the discussion of data, including the suggestion that it can be used for explaining the probable causes for changes in flow characteristics. The concept of film thickness and the character of the outermost "layers" are used to describe the causes for behavior such as thixotropy. (auth)

30947 (DMIC-Memo-166) LITERATURE SURVEY ON THE EFFECT OF SONIC AND ULTRASONIC VIBRATIONS IN CONTROLLING GRAIN SIZE DURING SOLIDIFICATION OF STEEL INGOTS AND WELDMENTS. J. G. Kura and H. W. Mishler (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). May 15, 1963. Contract AF33(616)-7747. 35p.

A review is presented in detailed abstract form of the pertinent papers dealing with grain refinement of alloys by vibrational energy. The present state of the art is summarized, and the directions that may lead to fruitful further progress are indicated. (N.W.R.)

30948 (GEAP-3653) AEC FUEL CYCLE PROGRAM. DESIGN AND FABRICATION OF THE BASIC FUEL ASSEMBLIES. C. J. Baroch, J. P. Hoffmann, and W. C. Rous (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Mar. 15, 1963. Contract AT (04-3)-189. 45p.

The basic fuel for the Fuel Cycle Program consists of 50 fuel rod assemblies, which were fabricated by current commercial methods. The purpose of these fuel assemblies is to study the effect of design, fabrication, and performance variables that could influence fuel life. Ten stainless-steel-clad control-rod-follower fuel assemblies (designated Type H), containing UO_2 pellets of 2.76% enrichment, were fabricated. These assemblies are attached at the bottom of the control rods and are raised into the core as the control rods are withdrawn. Sixteen stainless-steel-clad fuel assemblies (designated Type I), containing UO_2 pellets of 3.22% enrichment were fabricated along with 24 Zircaloy-clad assemblies (designated Type J), containing UO_2 pellets of 2.76 to 4.3% enrichment. Twenty-three of the Type J assemblies were fabricated with Zircaloy-2 cladding. One assembly contains 3 rods clad with Zircaloy-4 and 13 rods clad with Zircaloy-2. One Zircaloy-2-clad assembly was modified to accommodate the irradiation of short fuel segments containing natural UO_2 pellets enriched with 1.5% PuO_2. One of the stainless-steel-clad, type I, and two of the Zircaloy, type J, assemblies were instrumented to provide data on in-core neutron flux, coolant temperature, pressure drop, and coolant flow rates for the VBWR stability tests. These instrumented assemblies contain only 14 fuel rods. Twenty-five stainless steel clad assemblies were loaded into the VBWR in September 1960. The twenty-sixth stainless steel assembly was instrumented and inserted in the VBWR in October 1961. Nine Zircaloy clad assemblies were inserted in the VBWR in June 1961, and 12 Zircaloy clad assemblies were installed in August 1961. Two instrumented Zircaloy clad assemblies were inserted in October 1961. The last Zircaloy clad assembly was placed in the VBWR in January 1962. A summary of the characteristics of each fuel assembly is presented. Data obtained during the fabrication of the fuel rods and assemblies were recorded. (auth)

30949 (NAA-SR-8412) FABRICATION OF URANIUM ALLOY FUEL ELEMENTS FOR OMRE FOURTH CORE. R. M. Crawford and E. E. Garrett (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1963. Contract AT(11-1)-Gen-8. 30p.

The fuel elements for the fourth core loading of the Organic Moderated Reactor Experiment (OMRE) consist of nickel-plated U–Mo alloy fuel, isostatically bonded to Type 1100 aluminum cladding. The fuel elements are flat-plate elements, with 18 fuel plates per element. Thirty-four Core IV fuel elements were fabricated. Twenty standard driver elements and five instrumented driver elements were made of U–3.8 Mo–0.2 Al. Three test elements each of U–3.8 Mo–0.2 Al, U–7.5 Mo, and U–10 Mo, for a total of nine test elements, were also made. All fabrication techniques used in this program were in accordance with nuclear safety criteria. (auth)

30950 (NMI-2117) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission for the Month of April 1963. (Nuclear Metals, Inc., Concord, Mass.). July 2, 1963. Contract AT(30-1)-2784. 35p.

Progress is reported on studies of the fundamentals of single crystal deformation in zone-refined beryllium, high-temperature properties of refractory metal alloys, development of uranium-base alloys strengthened by SLIS techniques, and the extrusion and drawing of rhenium-tungsten tubing. (B.O.G.)

30951 (NP-12964) FABRICATION OF ULTRAFINE BERYLLIUM WIRE. Technical Report No. 314-240. Bimonthly Report No. 2, March 25, 1963–May 24, 1963. E. A. Murphy, A. G. Gross, Jr., and R. G. O'Rourke (Brush Beryllium Co., Cleveland). May 24, 1963. Contract NOw-63-0137-c. 13p.

The results of work directed toward development of a process for the production of ultrafine beryllium wire by warm-drawing techniques are described. Using conventional drawing techniques, beryllium wire with a minimum diameter of 0.001420 inch is attained. (auth)

30952 PREPARATION OF URANIUM DIOXIDE FOR SINTERING. Sho Mizusawa (Sumitomo Metal and Mining Co., Ltd., Tokyo). Genshiryoku Kogyo, 9: No. 4, 10-16 (Apr. 1963). (In Japanese)

A method was developed for the preparation of powdered UO_2 to be used in fuel elements. A uranate, $(NH_4)_2O \cdot nUO_3$, where n = 6, was obtained by reacting $UO_2(NO_3)_2$ with gaseous NH_3. The UO_2 formed by the uranate, the latter being designated as APU, by sintering has a high compaction density. X-ray-diffraction and differential thermal analysis failed to reveal any differences between APU and the other compound, ADU, with a composition of $(NH_4)_2O \cdot 2UO_3$. The method is applicable to both natural and enriched uranium compounds. Currently used fabrication methods are reviewed and compared with the APU method. (TTT)

30953 FRICTION COEFFICIENT AS FUNCTION TEMPERATURE AND SURROUNDING MEDIA IN ROLLING OF IRON, TITANIUM, MOLYBDENUM AND NIOBIUM. I. M. Pavlov, A. P. Bashchenko, Ya. B. Gurevich, V. L. Orzhekhovskii, and A. E. Shelest. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 3, 123-6(May-June 1963). (In Russian)

Friction coefficients for Fe, Ti, Mo, and Nb rolling in a vacuum and in technically pure air were determined as functions of the temperature and surrounding media. It was found that in hot rolling the contact friction varies in transition from the air into a vacuum (the friction coefficient for Ti drops and for Fe, Mo, and Nb it rises). (R.V.J.)

30954 COATING COSTS FOR CERAMIC-COATED NUCLEAR-FUEL PARTICLES. J. H. Oxley (Battelle Memorial Inst., Columbus, Ohio), M. F. Browning, J. M. Blocker, Jr., and C. E. Dryden. Nucl. Sci. Eng., 16: 280-90(July 1963).

Cost estimates for coating nuclear fuel particles show that carbon coatings are the least expensive type studied. Alumina coatings are an order of magnitude more expensive, and beryllia coatings appear to be even more costly because of a $26/lb BeO burden as a result of the cost of beryllium metal feed. Because UO_2 appears to be inherently a cheaper fuel than UC_2, from a materials-preparation standpoint, a carbon-coated UO_2 fuel is attractive. However, the radiation performance of the various fuels is obviously the controlling factor. For commercial quantities of 40-μ coatings on 127-μ fuel particles, the more optimistic coating prices are approximately equivalent to a 0.02 mil/kw-hr charge for carbon coatings, 0.1 mil/kw-hr for alumina coatings, and 1 mil/kw-hr for beryllia coatings at 10,000 Mw-day/tonne burnup, on the basis of estimates for reactors having thermal efficiencies of 28%. (auth)

30955 ELECTRON BEAM WELDING OF ZIRCALOY AND OTHER MATERIALS. Herbert S. Kalish (United Nuclear Corp., White Plains, N. Y.). 29p. (CONF-53-1)

From AEC-ASM Welding Forum National Metals Congress, New York, Nov. 1962.

An investigation was conducted on the effects of electron beam welds on the properties of Zircaloy-2. Tensile tests and corrosion tests in 680°F water were carried out, and chips from the welded areas were analyzed for possible volatilization of alloying elements. It is concluded that electron beam welding has minimum effects on the properties of Zircaloy-2 except for a decrease of 10 ppm in the hydrogen content. A review is also presented of other investigations on the electron beam welding of other materials such as aluminum, beryllium, titanium, molybdenum, and tungsten. (D.L.C.)

30956 PROCESS OF THE ENCAPSULATION OF PARTICULATE MATERIAL. (to Upjohn Co.). British Patent 930,422. July 3, 1963. Priority date Dec. 22, 1958, United States.

Particles can be encapsulated in membranes with greater impermeability by forming a membrane containing a gelable hydrophilic colloid around the particles by a liquid-liquid phase separation process, setting the membranes, dispersing them in an aqueous medium with a pH of 4 to 6, and spray-drying the encapsulated particles from the medium. (D.C.W.)

30957 COVERING A CORE BY EXTRUSION. Anthony J. Karnie (to U. S. Atomic Energy Commission). U. S. Patent 3,098,022. July 16, 1963.

A method of covering a cylindrical fuel core with a cladding metal is described. The metal is forced between dies around the core from both ends in two opposing skirts, and as these meet the ends turn outward into an annular recess in the dies. By cutting off the raised portion formed by the recess, oxide impurities are eliminated. (AEC)

30958 FOIL ELEMENT FOR NUCLEAR REACTOR. Robert A. Noland, David E. Walker, and Bernard I. Spinrad (to U. S. Atomic Energy Commission). U. S. Patent 3,098,025. July 16, 1963.

A method of making a foil-type fuel element is described. A foil of fuel metal is perforated in a regular design and sheets of cladding metal are placed on both sides. The cladding metal sheets are then spot-welded to each other through the perforations, and the edges sealed. (AEC)

30959 PLUTONIUM ELECTROREFINING CELLS. Lawrence J. Mullins, Jr., Joseph A. Leary, Carl W. Bjorklund, and William J. Maraman (to U. S. Atomic Energy Commission). U. S. Patent 3,098,028. July 16, 1963.

Electrorefining cells for obtaining 99.98% plutonium are described. The cells consist of an impure liquid plutonium anode, a molten $PuCl_3$–alkali or alkaline earth metal chloride electrolyte, and a nonreactive cathode, all being contained in nonreactive ceramic containers which separate anode from cathode by a short distance and define a gap for the collection of the purified liquid plutonium deposited on the cathode. Important features of these cells are the addition of stirrer blades on the anode lead and a large cathode surface to insure a low current density. (AEC)

30960 HIGH ENERGY RATE EXTRUSION OF URANIUM. L. Lewis (to U. S. Atomic Energy Commission). U. S. Patent 3,098,807. July 23, 1963.

A method of extruding uranium at a high energy rate is described. Conditions during the extrusion are such that the temperature of the metal during extrusion reaches a point above the normal alpha to beta transition, but the metal nevertheless remains in the alpha phase in accordance with the Clausius-Clapeyron equation. Upon exiting from the die, the metal automatically enters the beta phase, after which the metal is permitted to cool. (AEC)

Properties and Structure

Refer also to abstracts 30151, 30152, 30201, 30202, 30832, and 30833.

30961 (ASD-TDR-62-204(Pt.II)) THERMODYNAMIC AND KINETIC STUDIES FOR A REFRACTORY MATERIALS PROGRAM. L. A. McClaine, ed. (Little (Arthur D.) Inc., Cambridge, Mass.). May 1963. Contract AF33(616)-7472. 132p.

Studies during 1962 are reported on a program to provide the thermodynamic and kinetic data which are required to describe the chemical behavior of the zirconium and hafnium carbides and borides at temperatures to 3000°K and in atmospheres of O_2, $O_2 + H_2O$, Cl_2, HF, F_2, H_2, CO, NH_3, and N_2. Preparation of high purity ZrC, ZrO_2, HfB_2, and HfC is described. Experimental low temperature heat capacity data for ZrC and heat content data for ZrB_2 from 410 to 1126°K are presented. Current status of calorimetric, electron diffraction, equilibria, and spectroscopy studies are reported. Kinetic studies are described on the oxidation of ZrC from 550 to 650°C at one atmosphere oxygen pressure and from 850 to 1900°C at oxygen pressures of 3 to 26 torr, on the oxidation of ZrB_2 for the conditions 1200 to 1500°C and oxygen pressure of 7 to 38.75 torr and 945 to 1256°C at oxygen pressures up to one atmosphere, and on the fluorination of ZrC and ZrB_2. The results of metallographic examination of the oxidized ZrC and ZrB_2 samples are discussed. Electrical conductivity studies are reported on pure ZrO_2 from room to 1700°C. The oxidation kinetics of molybdenum metal were studied in the temperature range 1400 to 2000°K and oxygen pressures of 10^{-5} to 10^{-6} atmospheres using a mass spectrometer with necessary source modifications. (auth)

30962 (ASD-TDR-63-238) IMPURITY ATOM-DISLOCATION INTERACTIONS AND SUBSEQUENT EFFECTS ON MECHANICAL PROPERTIES OF REFRACTORY

METALS. H. R. Nesor and G. T. Murray (Materials Research Corp., Orangeburg, N. Y.). Feb. 1963. Contract AF33(657)-7687. 23p.

The interaction between dislocations and impurity atoms in electron-beam-refined arc-cast molybdenum single crystals was studied in the form of strain aging and tensile creep experiments. Data were obtained on the kinetics of the return-of-the-yield-drop process for molybdenum containing carbon at 475 to 650°C. This data yielded an activation energy of 21,400 cal/mol for the process. A Mo–1% Ta alloy was examined but strain aging effects were not observed. The tensile creep behavior of molybdenum containing carbon was compared with that for high purity materials. The presence of carbon greatly increased the creep resistance, while a polygonization treatment slightly decreased the creep resistance. The tendency for substructure to coarsen was found to be less in molybdenum containing carbon than in high purity material. (auth)

30963 (ATL-A-136) INVESTIGATION OF THERMAL-STRESS-FATIGUE BEHAVIOR OF STAINLESS STEEL. THE EFFECTS OF GAGE LENGTH AND SPECIMEN CONFIGURATION ON THERMAL-STRESS-FATIGUE TEST RESULTS. K. E. Horton (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). May 10, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 42p. (EURAEC-725)

The importance of the experimental method to thermal-stress-fatigue test results is clarified. It is shown that a significant increase in apparent fatigue life can be obtained by measuring maximum strain per cycle instead of an average strain. Extrapolation curves are given to convert the latter into the former. A varying-cross-section specimen of "zero" gage length is shown to allow measurement of true, maximum strain. (auth)

30964 (BMI-X-10050) FISSION-PRODUCT RELEASE FROM FUEL-ELEMENT CLADDINGS. Quarterly Progress Report for April–June 1963. Thomas S. Elleman, George G. Cocks, Josef Bugl, and Arthur A. Bauer (Battelle Memorial Inst., Columbus, Ohio). July 1, 1963. Work performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 9p. (EURAEC-741)

Postirradiation heating experiments to study xenon-133 release from foils of iron–chromium alloy specimens impregnated with fission recoils were performed at 600 to 1200°C. Release was found to be time, temperature, and concentration dependent. A low activation energy appears to be associated with a long-time release component. Significant release of xenon-133 was observed at 1100 and 1200°C through 10 mils of cladding during in-pile experiments; high release of fission gases from a specimen clad with 2 mils of foil was observed but is believed to have resulted from a defected specimen. In solid fission product studies the recoil distribution of cerium-141 in a plate of the iron–chromium alloy was found to be linear with distance. Diffusion anneals were performed at 800, 1000, and 1200°C and preliminary activation energies for the diffusion of tellurium-132, ruthenium-103, cerium-141, zirconium-95, barium-140, and iodine-131 vary from 23 to 65 kcal/mole. At the higher temperatures tellurium-132 and ruthenium-103 diffuse more rapidly than the remaining isotopes. (N.W.R.)

30965 (CONF-20-17) THE VISCOSITY AND DENSITY OF MOLTEN LANTHANUM, CERIUM AND PRASEODYMIUM METALS. L. J. Wittenberg, Donald Ofte, and W. G. Rohr (Mound Lab., Miamisburg, Ohio). [1962]. Contract [AT(33-1)-Gen-53]. 25p.

From Third Rare Earth Conference, Clearwater, Fla., Apr. 1963.

The density and viscosity of molten lanthanum, cerium, and praseodymium metals are reported from their melting points to 1000°C. (M.C.G.)

30966 (CONF-22-15) SPECIFIC HEATS OF ZIRCONIUM ALLOYS AT LOW TEMPERATURES. G. D. Kneip, Jr., J. O. Betterton, Jr., and J. O. Scarbrough (Oak Ridge National Lab., Tenn.). Nov. 13, 1962. Contract [W-7405-eng-26]. 34p.

From American Physical Society Annual Meeting, New York, Jan. 1963.

The specific heats of dilute alloys of silver, cadmium, indium, tin, and antimony in hexagonal zirconium were measured from 1.2 to 4.5°K. For each alloy the specific heat obeyed the relation $c = \gamma T + \beta T^3$ within the experimental error. All of these solutes increased γ linearly with concentration and $d\gamma/dx$ was linearly related to the chemical valence of the solute. The increase in γ in the tin–zirconium alloys showed that all electrons outside closed shells cannot be treated as equivalent in the rigid band model of alloying. All of these solutes increased the density of states of zirconium, providing evidence for a zone overlap in the zirconium d band and for a small number of electrons in a new band. All of the solutes increased the lattice specific heat and the Debye temperature was a linear function of solute concentration for each of these alloy systems. The function $d\theta/dx$ was not simply related to the solute valence but showed a close correlation with the magnitude of the rate of change of the distance between atoms at 000 and $\frac{1}{3}$, $\frac{2}{3}$, and $\frac{1}{2}$ of the hexagonal cell. Additions of tin to zirconium did not change the average interaction potential of the BCS theory appreciably. (auth)

30967 (CONF-23-5) ANTIFERROMAGNETISM OF EuTe. G. Will (Army Electronics Research and Development Lab., Fort Monmouth, N. J. and Brookhaven National Lab., Upton, N. Y.); S. J. Pickart, H. A. Alperin (Naval Ordnance Lab., White Oak, Silver Springs, Md. and Brookhaven National Lab., Upton, N. Y.); and R. Nathans (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 13p.

From American Physical Society Meeting, St. Louis, Mar. 1963.

A neutron diffraction study was made of EuTe to establish the magnetic type of ordering. Using the crystallographic lattice constant of 6.60 Å, only one nuclear peak was observed. However, additional superlattice peaks were found at low temperatures, indicating an antiferromagnetic structure. EuTe crystallized in the fcc rock-salt structure above the Neel point. The spins are parallel within (111) planes which are stacked together in an antiparallel sequence along the [111] direction. (M.C.G.)

30968 (CONF-50-4) PHYSICAL PROPERTIES OF SINTERED BeO AS INFLUENCED BY MICROSTRUCTURE. B. A. Chandler and R. E. Fryxell (General Electric Co. Advanced Technology Services, Cincinnati). [1963]. Contract AT(40-1)-2847. 65p. (TM-63-5-4)

From American Ceramic Society Annual Meeting, Pittsburgh, Apr.-May 1963.

Physical properties are presented for extruded and sintered BeO from 25 to 1400°C as a function of porosity (0 to 15%), grain size (5 to 100 microns), and grain orientation (random to 80% preferred). The elastic constants and linear thermal expansion are sensitive to the degree of pre-

ferred grain orientation. Measurements on polycrystalline specimens permitted calculation of the anisotropy in single crystals of BeO. Modulus of rupture data is treated in terms of the Knudsen equation and compressive creep data in terms of the Nabarro-Herring equation, the latter leading to estimates of the diffusion coefficient for Be at 1200°C. (auth)

30969 (DRI-2059) INVESTIGATION OF HYDRIDING CHARACTERISTICS OF INTERMETALLIC COMPOUNDS. Summary Report, November 1, 1960 to September 31, 1962. Richard L. Beck (Denver. Univ. Denver Research Inst.). Oct. 15, 1962. Contract AT(33-3)-3. 63p.

The experimental results of an extensive investigation of the hydriding characteristics of intermetallic phases are described. These results were critically analyzed and a pragmatic theory was developed from which it was possible to predict or explain nearly all phases of the hydrogen occlusion phenomena associated with the metallic hydrides. (auth)

30970 (GEST-2015) ELECTRICAL CONDUCTIVITY, THERMAL CONDUCTIVITY, AND THERMAL EMISSION FOR FUEL-BEARING CARBIDES: UC_2, UC, $U_{0.5}Zr_{0.5}C$, AND ThC_2. L. N. Grossman (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Apr. 8, 1963. 31p.

Thermal conductivity, electrical resistivity, total hemispherical emittance (ϵ_t), and normal spectral emittance ($\epsilon_{0.65\,\mu}$) data were obtained from rod specimens of UC_2, UC, $U_{0.5}Zr_{0.5}C$, and ThC_2 in the temperature range 1100 to 2400°K. The results are presented in graphs and tables. (auth)

30971 (IITRI-B6007-3) DISPERSION-STRENGTHENED VANADIUM ALLOYS. Bimonthly Report No. 3, April 14, 1963–June 13, 1963. F. C. Holtz (Illinois Inst. of Tech., Chicago. IIT Research Inst.). July 16, 1963. Contract N600(19)59567. 17p.

Studies of dispersion-strengthening mechanisms in vanadium–niobium base alloys are described. Arc-melted alloys based on V–60 wt % Nb and V–40 wt % Nb–30 wt % Ta, with hafnium or zirconium and carbon, were solution-annealed at temperatures up to 3000°F and aged at 2000 and 2300°F. The most stable alloy on the basis of hardness was V–40 wt % Nb–30 wt % Ta–1 wt % Zr–0.1 wt % Nb, and this composition retained a comparatively fine grain size during all heat treatments. Initial creep tests were conducted on pack-siliconized specimens which were stressed in 2000°F air. Powder metallurgy techniques were used to prepare V–60 wt % Nb–1 wt % Ti alloys containing dispersed oxide or carbide powders. After sintering the blended and compacted powders at 2800°F and annealing at 2400°F, the most stable dispersants on the basis of microstructures were yttria and hafnium carbides. (auth)

30972 (KAPL-2286) STUDIES OF THE SYSTEM ZIRCALOY-2–NIOBIUM–OXYGEN. A. E. Bibb and J. R. Fascia (Knolls Atomic Power Lab., Schenectady, N. Y.). June 1963. Contract W-31-109-eng-52. 13p.

The additions of niobium and oxygen to Zircaloy-2 were found to increase the mechanical strength at temperatures up to ~500°C. Hardness variations produced by recrystallization of 10 to 20% cold-worked Zircaloy-2–niobium–oxygen alloys were found to be masked by variations caused by annealing-induced structural changes involving omega formation. High-temperature x-ray, dialatometer, and differential-thermal-analysis studies were used to investigate the phase relationships in these alloys. The monotectoid temperature in the pseudoternary diagram of Zircaloy-2–niobium was determined as 605°C. Oxygen had no apparent effect on this temperature. The maximum solubility of niobium in Zircaloy-2 was found to be below 2.5 wt.% niobium for all alloys containing between 700 and 3500 ppm oxygen. Isothermal sections of the pseudo-ternary phase diagram for Zircaloy-2–niobium–oxygen for specific temperatures in the range 800 to 1000°C are presented and discussed. (auth)

30973 (LA-2912) A NEUTRON DIFFRACTION EXAMINATION OF ALPHA PLUTONIUM AT 23°K. R. B. Roof, Jr. (Los Alamos Scientific Lab., N. Mex.). May 1963. Contract W-7405-eng-36. 27p.

A neutron-diffraction pattern obtained by the transmission method from a thin slab of Pu at 23°K was analyzed in terms of an analytical expression consisting of the summation of Gaussian peaks. The angular positions of the Gaussian peaks were indexed in terms of a monoclinic unit cell which compares favorably with the room temperature cell given by Zachariasen. The intensities of the Gaussian peaks yield a structure essentially in agreement with the room temperature structure but with the important differences of a reduction in the average number of neighbors from 14 at room temperature to 12.5 at the low temperature, indicating a tendency of the atoms to cluster; and a reduction in the gross average Pu–Pu interatomic distance from 3.19 Å at room temperature to 3.16 at the low temperature. This small contraction in the average distance is not significant, however, because of the rather large standard deviations observed for the individual interatomic distances. (auth)

30974 (LAMS-2906) A NEW BRITTLENESS TEST FOR POWDER METALLURGY MATERIALS. William H. Lenz (Los Alamos Scientific Lab., N. Mex.). June 1, 1963. Contract W-7405-eng-36. 27p.

A brittleness test, based on the Brinell ball impression in a standard specimen at the moment of rupture, was found to be applicable to materials which show some compressive ductility along with low tensile elongation. The test was evaluated on sintered specimens of W, Mo, Ta, and their alloys, as well as on cermets of these metals. The test is numerically based on the fact that the volume of the Brinell impression is very nearly proportional to the 4th power of the impression diameter between the limits used in the test. (auth)

30975 (NMI-4992) PAPERS PRESENTED AT THE X-RAY PREFERRED ORIENTATION MEETING HELD AT NUCLEAR METALS, INC., WEST CONCORD, MASSACHUSETTS ON DECEMBER 7-8, 1961. R. B. Russell, comp. (Nuclear Metals, Inc., West Concord, Mass.). May 9, 1963. Contract AT(30-1)-1565. 74p.

Seven papers presented at the X-Ray Preferred Orientation Meeting are given. Topics covered include: automation of x-ray diffraction unit for preferred orientation studies, NaK encapsulating facility, anisotropic growth vs preferred orientation in unrestrained uranium, residual textures in β-treated uranium, axial textures in As-extruded uranium tubes, irradiation growth in α-uranium single crystals, and texture induced during β treatment of uranium. (M.C.G.)

30976 (NMI-1256) FUNDAMENTALS OF SINGLE CRYSTAL DEFORMATION IN ZONE-REFINED BERYLLIUM. Final Report, July 1, 1961 through June 30, 1962. D. F. Kaufman, E. D. Levine, J. J. Pickett, and L. R. Aronin (Nuclear Metals, Inc., West Concord, Mass.). May 13, 1963. Contract AT(30-1)-2784. 67p.

A study was made of the fundamental deformation characteristics of beryllium single crystals purified by zone

refining. Single crystals 1/4 inch and 1 1/4 inches in diameter were prepared by floating zone refining. Mechanical property studies showed that the critical resolved shear stresses at room temperature for basal and prismatic slip decreased in a regular manner with decreasing impurity content, as measured by resistance ratio. Absolute decreases in critical stress were approximately equal for both kinds of slip for equivalent purifications. The lowest values of critical resolved shear stress obtained were 180 psi for basal slip and 7600 psi for prismatic slip. Large increases in basal plane ductility at room temperature, accompanied by decreases in the rate of work hardening, were produced by purification. Extensive ductility was observed in purified crystals at temperatures as low as −196°C, while at 425°C, brittle failure by basal cleavage was eliminated. At room temperature, basal slip eventually terminated in basal cleavage for all purities studied. Increases in basal ductility were related to the effect of purification on the split bend-plane model for basal cleavage. These effects involved a reduction in barriers to the motion of individual dislocations and to the motion of bend planes under an applied stress. The role of soluble and insoluble impurities in these processes is discussed. Purification also resulted in elimination of the brittle behavior following prismatic slip that is observed in commercial-purity crystals. (auth)

30977 (NP-12969) TRANSPORT STUDIES OF DEFECT STRUCTURE INORGANIC COMPOUNDS. Semi-Annual Technical Report, October 1, 1962−March 31, 1963. (Westinghouse Electric Co. Research Labs., Pittsburgh). Contract Nonr-3800(00). 109p.

A total of five papers are included. Separate abstracts were prepared for each paper. (J.R.D.)

30978 (NP-12969(Paper I)) SYSTEM $ThO_2-Y_2O_3$. E. C. Subbarao and P. H. Sutter (Westinghouse Electric Co. Research Labs., Pittsburgh).

Compositions in the $ThO_2-YO_{1.5}$ system were coprecipitated as the oxalates. Disks, pressed from decomposed oxalates, were sintered in oxygen at 1400 to 2200°C. Densities of the sintered disks were 96 to 98% of the theoretical. Solid solutions with the fluorite-type structure were formed up to 20 to 25 mole % $YO_{1.5}$ at 1400°C and up to 45 to 50 mole % $YO_{1.5}$ at 2200°C. Density data showed that these solid solutions correspond to $Th_{1-x}Y_xO_{2-0.5x}$, having a complete cation sublattice filled by the Th^{4+} and Y^{3+} ions and vacancies in the anion sublattice. The observed increase in electrical conductivity with increase in $YO_{1.5}$ is consistent with the notion that oxygen ions are the predominant charge carriers through a vacancy mechanism. (auth)

30979 (NP-12969(Paper II)) FLUORITE PHASE IN THE SYSTEM ZrO_2-CaO: X-RAY AND ELECTRICAL CONDUCTIVITY STUDY. T. Y. Tien and E. C. Subbarao (Westinghouse Electric Co. Research Labs., Pittsburgh).

In the ZrO_2-CaO system cubic solid solutions of the fluorite-type structure are formed between 12 and 22 mole % CaO for specimens fired at 2000°C and subsequently quenched from 1400°C. The lattice parameter increased linearly from 5.125 to 5.144 Å with increasing CaO content. Results of x-ray-diffraction intensity studies favored the oxygen ion vacancy model over the cation interstitial model for these solid solutions. As the CaO content was increased from 13 to 20 mole %, the electric conductivity at 1000°C decreased from 5×10^{-2} to 6×10^{-3} ohm^{-1} cm^{-1} and the activation energy increased from 1.11 to 1.35 ev. Specimens heated at 1000°C for one week showed extra x-ray-diffraction lines. These data coupled with accompanying changes in electric conductivity are discussed in terms of an order-disorder transition. (auth)

30980 (NP-12969(Paper III)) ORDER-DISORDER AND IONIC CONDUCTIVITY IN CUBIC ZrO_2-CaO. E. C. Subbarao and P. H. Sutter (Westinghouse Electric Co. Research Labs., Pittsburgh).

Evidence concerning the order-disorder phenomenon and the associated ionic conductivity changes in solid solutions is presented. A cylindrical specimen of $Zr_{0.82}Ca_{0.18}O_{1.82}$ sintered at 2000°C and painted with Pt paste was used in the electric conductivity measurements at 1000 cps. Tests of cycling between ordered and disordered states showed that the effect is related to recoverable structural changes. The conductivity changes with time during the disorder-order transition were also studied. Results indicate that the conductivity change is interpreted as an order-disorder phenomenon rather than the precipitation of a second phase. (J.R.D.)

30981 (NP-12969(Paper IV)) CONDUCTION PROPERTIES OF $Cd_2Nb_2O_7$ AND $Pb_{1.5}Nb_2O_{6.5}$. R. Mazelsky and W. E. Kramer (Westinghouse Electric Co. Research Labs., Pittsburgh).

Investigations directed toward elucidation of the type of conductivity in these materials are described. Preparation and composition of the experimental solid solution series are discussed along with resistance measurements. It was found that below 1000°C $Cd_2Nb_2O_7$ appears to be predominantly an ionic conductor. $Pb_{1.5}Nb_2O_{6.5}$ is an electronic conductor. The variation of resistivity with composition was not clarified. (J.R.D.)

30982 (NP-12969(Paper V)) A STUDY OF TRANSPORT PROPERTIES OF MIXED-VALENCE SEMICONDUCTORS. R. R. Heikes, A. A. Maradudin, and R. C. Miller (Westinghouse Electric Co. Research Labs., Pittsburgh). (In French)

The transport and magnetic properties of mixed-valence semiconductors are studied. It is assumed that the conduction involves a thermally activated process in which the charge carriers jump from site to site. The activation energy, ΔH_c, required for a jump is calculated assuming that a jump can only take place when the atomic configuration surrounding a charge carrier and that surrounding a neighboring site are energetically equivalent. This activation energy is related to the force constants and in turn to the differences in size of the cation in the two valence states. The trapping mechanism is shown to be more plausible than the long-range polarization effects previously proposed. A calculation of the Seebeck coefficient (α) on the model shows that the contribution owing to the activated process is normally small and of the order of $1/20\ \Delta H_c/eT$. Magnetic effects give rise to a small contribution to α and slightly modify the temperature dependence of the electric conductivity. No discontinuities in the transport properties are expected at the Curie temperature. To explain the properties at high carrier concentrations, it is found necessary to modify the concept of free carriers, and in addition consideration must be given to determining the number of sites accessible to the carrier. (auth)

30983 (NUMEC-P-55) DEVELOPMENT OF PLUTONIUM-BEARING FUEL MATERIALS. Monthly Progress Letter, February 1963. Karl H. Puechl (Nuclear Materials and Equipment Corp., Apollo, Penna.). Mar. 5, 1963. Contract AT(30-1)-2389. 5p.

All 14 capsules for the initial set of irradiation experiments are ready for shipment to the test reactor site. Ef-

fort is continuing on completion of post-irradiation examination facilities. An additional PuO_2 preparation run was made via the peroxide route; powder characterization studies of all batch preparations made via this route were completed and indicated that the characteristics are reproducible. Fuel compatibilities with claddings and coolants are being studied. The plasma torch fusion and spheroidization studies using UO_2-PuO_2 are being continued. Thermogravimetric investigations were initiated to determine the oxidation kinetics of UO_2-PuO_2 solid solutions. (M.C.G.)

30984 (RISÖ-58) HIGH TEMPERATURE STABILITY OF SINTERED ALUMINIUM PRODUCTS EXAMINED BY DENSITY MEASUREMENTS. Niels Hansen and Keith W. Jones (Denmark. Atomenergikommissionen, Roskilde). Mar. 1963. 19p.

The structural stability of the sintered aluminum product SAP at elevated temperature was investigated. Heat treatment in air at 600°C of SAP with a high gas content resulted in formation of fissures accompanied by a simultaneous decrease in density. The total volume of fissures formed decreased with increasing high temperature strength of the SAP materials for equal gas contents. The heat-treated material could be densified to the original state by hot compaction at 550°C. A material degassed during manufacturing before the final compaction was found to be stable during the heat treatment in air at 600°C. A degassing treatment of SAP in vacuum at 600°C reduced the density slightly without changing the microstructure of the products. The density decrease was proportional to the oxide content of SAP. Heat treatment of the degassed SAP in air at 600°C resulted in an extremely small density decrease without changing the microstructure of the products. Densification of SAP in the as-delivered condition by hot compaction at 550°C was only possible to a limited degree. A large densification was obtained in some of the materials by hot compaction after a vacuum degassing at 600°C. SAP materials heat treated and hot compacted to maximum densities showed a straight line relationship between the density and the oxide content. The density of the oxide phase in these materials was calculated to 3.37 g/cm^3. (auth)

30985 (TID-19070) ATOMIC ARRANGEMENTS, IMPERFECTIONS AND DIFFUSION. Progress Report. B. L. Averbach and Morris Cohen (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). June 18, 1963. Contract AT(30-1)-2879. 7p.

The short-range order and size-effect coefficients due to quenching at 300, 900, and 1000°C are presented for an aluminum–iron alloy. Static displacements and Debye temperatures of the atoms from the average lattice sites are studied for solid solutions of iron–chromium, nickel–chromium, and copper–nickel by x-ray-diffraction measurements at several temperatures. Work is under way in the nucleation studies of gold–nickel alloys. Atomic displacements and short-range order in iron–silicon systems are discussed. Thermodynamic studies of iron–nickel alloys are under way. Simultaneous creep and self-diffusion measurements are reported for nickel and gold. (N.W.R.)

30986 (TNPG-401) CREEP OF URANIUM AT 550°C UNDER A TENSILE STRESS OF 350 PSI. W. S. Blackburn (Nuclear Power Group, Knutsford, Ches., England). June 1963. 12p. (TRG-Report-535(S/X); NPCC/FEWP(63)P57)

Results are presented of the creep of uranium under a tensile stress of 350 psi at 550°C under conditions of constant temperature, continuous small thermal cycles, discrete large cycles, and combined continuous small and discrete large cycles. The creep rates under isothermal conditions and discrete cycling were larger than predicted from previous results, but under continuous cycling they agreed well with predictions based on a value of internal stress per mean temperature deviation of 250 psi/°C for a variety of amplitudes and periods of cycle. (auth)

30987 (AEC-tr-5873) X-RAY SPECTRA AND THE INTERATOMIC BOND IN SOLID METALLIKE COMPOUNDS. V. S. Neshpor. Translated from p.46-74 of "Vysokotemperaturnye Metallokeramicheskia Materialy." Kiev, 1962. 25p.

An attempt is made to establish a qualitative correlation between the basic physical properties and structure of metal-like compounds, and the state of their metallic components as it is revealed by their soft x-ray spectra. A review of the characteristics of the metal-like compounds (solid refractory compounds of transition metals with carbon, nitrogen, boron, and silicon) is obtained from the 96 references listed. (N.W.R.)

30988 (FTD-TT-63-258) INVESTIGATING DIFFUSION MOBILITY OF ZIRCONIUM IN ZIRCONIUM–NIOBIUM ALLOYS. G. G. Ryabova and P. L. Gruzin. Translated from Met. i Metalloved. Chistykh Metal., Sb. Nauchn. Rabot, 3: 120-6(1961). 9p.

To investigate the diffusion of zirconium in Nb–Zr alloys, the selected alloys were melted in an arc furnace in an atmosphere of purified argon. The samples were subjected to homogenizing annealing, labeled with Zr^{95}, and subjected to diffusion annealing in vacuum. The diffusion of zirconium changed in dependence on the niobium content of the alloys. The mobility decreased gradually with a rise in niobium up to 50%, and then there was a sharp drop in the diffusion coefficient. The diffusion of niobium in zirconium was also measured using Nb^{95} in the form of niobium oxide. (M.C.G.)

30989 (TRG-Inf.-Ser.-310) METHODS OF DETECTING SECOND ORDER STRESSES AND OF MEASURING BLOCK SIZES. Y. M. Golovchiner. Translated by R. Hardbottle from Zavodsk. Lab., 26: 431-44(1960). 22p.

The detection of second-order stresses and measurement of block sizes in studies of intergranular structure are discussed. Two methods using x rays are described: harmonic analysis, the experimental basis of which is the shape of the x-ray interference line, and the integral (approximation) method, the experimental basis of which is the breadth of the line. Equations used in these methods are given. A way of taking the anisotropy of the elastic properties of crystals into account is discussed. The choice of lines, selection of the approximating function, and ways of reducing the instrumental aberration are also considered. (M.C.G.)

30990 ON DISTURBANCE OF SUPERCONDUCTIVITY. E. Troinar (Inst. of Physics, Polish Academy of Sciences, Wrocław). Acta Phys. Polon., 23: 567-79(Mar. 1963). (In Russian)

Superconducting disturbances of the resistance of a cylindrical sample of tin were measured in intermediate stages as a function of current. Ferromagnetic powder methods were used to determine the structure of the cylinder in intermediate states as a function of current in a transverse magnetic field. Measurements confirmed the London scheme of intermediate states in the cylinder. It was determined that the experimental value of the resistance for the critical current in the normal state differed only slightly from the theoretical value of 0.5 as a result

of the helium bath. Surface tension on the superconductor in the normal state and the dispersion of conduction electrons at the phase boundary did not play a noticeable role in the current dependence of the resistance. (tr-auth)

30991 TRANSVERSE MAGNETORESISTANCE OF HIGH PURITY ALUMINIUM FROM 4 TO 30°K. J. R. Purcell and R. B. Jacobs (National Bureau of Standards, Boulder, Colo.). Cryogenics, 3: 109-10(June 1963).

Magnetoresistance measurements at 4, 20, 25, and 30°K were made on two commercially available high-purity aluminum samples. The data are plotted on resistivity vs field graphs and on Kohler graphs. The data are in good agreement with these from the literature. (D.L.C.)

30992 ON THE APPLICATION OF γ-SPECTRAL METHOD IN THE INVESTIGATION OF SIMULTANEOUS TWO COMPONENT DIFFUSION PROCESSES. P. V. Pavlov and V. A. Uskov (Gor'kii Inst. of Physics and Tech., USSR). Fiz. Metal. i Metalloved., 15: 105-8(Jan. 1963). (In Russian)

Descriptions are given of a differential γ discrimination using a single crystal scintillation spectrometer. The method was tested using Cs^{137} and Fe^{59} mixtures. Results on Fe^{59} diffusion in Fe–Mo–C were in good agreement with data obtained using a Geiger-Mueller counter and a γ spectrometer. (R.V.J.)

30993 CONSTITUTION DIAGRAM OF Nb–Sn ALLOY. V. S. Kogan, A. I. Krivko, B. S. Lazarev, L. S. Lazareva, A. A. Matsakova, and O. N. Ovcharenko (Khar'kov Inst. of Physics and Tech.). Fiz. Metal. i Metalloved., 15: 143-5 (Jan. 1963). (In Russian)

Specially prepared specimens of Nb–Sn soaked in liquid tin at various temperatures were used in studies of the Nb_3Sn constitution diagram and superconducting properties. X-ray and electric measurements of the Sn–Nb diffusion layer revealed different structures and superconducting properties for layers formed below and above 850 to 860°C. Correlation data revealed a new intermetallic modification that formed in addition to the Nb_3Sn compound at temperatures below 850°C. A new constitution diagram, including the new intermetallic, was constructed, and it is shown that Nb solubility in liquid tin is below the point indicated in previous diagrams. Continuous soaking of Nb and Nb_3Sn crystals in tin showed that the saturation point is reached at 900°C following the dissolution of 1 at. % Nb in tin. (R.V.J.)

30994 MAGNETIC AND HYSTERESIS PROPERTIES OF DYSPROSIUM AND TERBIUM. S. A. Nikitin (Moscow State Univ.). Fiz. Metal. i Metalloved., 15: 187-93(Feb. 1963). (In Russian)

Investigations of the temperature dependence of residual magnetization and coercive force (H_c) revealed a maximum H_c near the ferromagnetic-helicoil transition point at 95°K for Dy and 219°C for Tb. The residual magnetization of Dy and Tb decreased linearly with increasing temperature until a sharp drop was reached near the θ_1 point (θ_1 = 85°K for Dy and 219°K for Tb). (R.V.J.)

30995 TANTALUM STRUCTURE AT ELEVATED TEMPERATURES. V. M. Amonenko, B. M. Vasyutinskii, G. N. Kartmazov, Yu. N. Smirnov, and V. A. Finkel (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Fiz. Metal. i Metalloved., 15: 444-50(Mar. 1963). (In Russian)

The structure and thermal properties of 99.98% pure Ta treated in a vacuum at 20 to 2600°C were studied. It is shown that the two maximums on the a = f(T) curves are related to the temperature effects on adsorption and diffusion processes. (R.V.J.)

30996 DUCTILITY OF POLYCRYSTALLINE NIOBIUM AT HELIUM TEMPERATURES. I. A. Gindin and Ya. D. Starodubov. Fiz. Metal. i Metalloved., 15: 736-47(May 1963). (In Russian)

Temperature dependence of Nb yield strength and ductility at elongation of 0.03 mm/sec at 1.4 to 300°K were investigated. It is shown that high purity Nb retains its ductility up to absolute zero. The relative elongation at 1.4°K is 8 to 10% and transverse contraction is 50 to 60%. It was found that cold shortness is related to admixtures and not to the crystalline lattice. (tr-auth)

30997 HEAT CAPACITY OF LIQUID ALKALI METALS. Y. P. Os'minin (All-Union Correspondence Inst. of Power Engineering, Moscow). Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 4, 75-7(Apr. 1963). (In Russian)

The heat capacity of some molten alkali metals was studied. Heat capacities for liquid Rb and Cs up to 800°C were calculated by the method of thermodynamic similarity. (auth)

30998 DENSITY AND VISCOSITY OF NIOBIUM AND TANTALUM PENTACHLORIDES. L. A. Nisel'son and A. I. Pustil'nik. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 3, 110(May-June 1963). (In Russian)

The $NbCl_5$ density at 204.2° (melting point) to 325°C was found to be $2.0737 - 3.115 \times 10^{-3}\Delta t + 3.58 \times 10^{-6} \cdot \Delta t^2$ and the viscosity η, $0.921 - 1.325 \times 10^{-2}\Delta t + 1.120 \times 10^{-4}\Delta t^2 - 4.30 \times 10^{-7} \cdot \Delta t^3$ at 204.2 to 315°C with mean order of error $\Delta\rho_{square} < 0.002$ and $\Delta_\eta = 0.005$, respectively. The density of $TaCl_5$ is $2.6840 - 4.100 \times 10^{-3}\Delta t$ at 216.2 to 305°C and viscosity η, $1.003 - 1.667 \times 10^{2} \cdot \Delta t + 1.8 \times 10^{-4}\Delta t^2 - 8.455 \times 10^{-7} \cdot \Delta t^3$ with mean order of error $\Delta\rho_{square} = 0.002$ and $\Delta\eta_{square} = 0.006$. (R.V.J.)

30999 SINGLE-CRYSTAL ELASTIC CONSTANTS OF BeO FROM POLYCRYSTALLINE MEASUREMENTS. L. H. Sjodahl and B. A. Chandler (General Electric Co., Cincinnati). J. Am. Ceram. Soc., 46: 351-2(July 21, 1963).

Young's modulus for single BeO crystals can be deduced from measurements and orientation distribution functions of several polycrystalline BeO specimens having different degrees of preferred grain orientation. An equation for the modulus in terms of the angle with the c axis was derived and is plotted; the curve has the same general shape as that of CdS, which is in the same space group as BeO. The modulus in the direction of the c axis is 66.2×10^6 psi. (D.L.C.)

31000 THE SOLUBILITY OF ZIRCONIUM IN MAGNESIUM–LITHIUM ALLOYS. P. D. Demaine and G. A. Fowler (Magnesium Elektron Ltd., Manchester, Eng.). J. Inst. Metals, 91: 380-1(July 1963).

The solubility of Zr in Mg–Li alloys was studied and found to decrease from 0.6% for pure Mg to zero at ~6% Li. Some β phase was found in the α grain boundaries of the ternary alloys of up to ~5.5% Li, whereas binary Mg–Li alloys of comparable Li content consisted entirely of α phase. The lowering of Zr solubility in Mg–Li alloys may be related to the opposite effects of Li and Zr on the axial ratio of Mg crystals. (D.L.C.)

31001 MAGNETIC STUDY OF Fe_3Si AND Fe_5Si_3 BY MÖSSBAUER EFFECT. Teruya Shinjo (Kyoto Univ.), Yoji Nakamura, and Naomoto Shikazono. J. Phys. Soc. Japan, 18: 797-801(June 1963).

Mössbauer measurements were made on ferromagnetic Fe_3Si and Fe_5Si_3 to investigate the magnetic structure. In

the ordered crystal of Fe_3Si, two internal fields of 320 and 205 kgauss were found at liquid nitrogen temperature, corresponding to the two crystallographically different sites, Fe(I) and Fe(II). Since Fe(II) has a small magnetic moment, a low internal field and a large isomer shift, its electronic structure may be fairly modified by a formation of covalent bond with Si atom. On the other hand, the situation of Fe(I) seems to be little changed from that of Fe atom in pure iron. Fe_5Si_3 also has two different sites and two internal fields of 230 and 130 kgauss at liquid nitrogen temperature. Both kinds of Fe seem to be considerably different from Fe in pure iron. (auth)

31002 THE DISTRIBUTION OF Be AND THE GRAIN SIZE ON Mg–Al ALLOYS CONTAINING Be. Riei Ichikawa and Reiko Saito (Nagoya Inst. of Tech., Japan). Nippon Kinzoku Gakkaishi, 27: 32-7(Jan. 1963). (In Japanese)

The distribution of Be in Mg–Al–Be alloys was investigated in order to obtain some information about the effect of Be on the grain coarsening phenomena of cast structure at Be small contents. The following results were obtained: (1) When Mg–Al–Be alloys were held at 700°C for 30 min in melting operation, it was found that Fe and Be in molten alloys sank to the bottom of the crucible. Such sinking effect was found to be remarkable on alloys containing more Fe, and was found to be slight on the alloys containing Cu and Mn as impurities. (2) In cast Mg–Al alloys containing Be of 0.005 to 0.5% in open molds, the Be content in the surface parts was found to be more condensed than in the inside average parts of cast specimens. In cast Mg–2Al–Be alloys, the distribution of Be in inside parts was observed to be uniform in the case of smaller Be content. (3) By x-ray diffraction analysis, the formation of the intermetallic compound $FeBe_2$ by Fe and Be was found possible. The formation of this compound may be probably one of the causes of the sinking effect of Be and Fe in molten Mg alloys and therefore this removal effect on Fe may be one of the causes of grain coarsening in the cast structure. (auth)

31003 $\{11\bar{2}1\}$ TWINNING. A. G. Crocker (Battersea Coll. of Tech., London). Phil. Mag. (8), 8: 1077-81(July 1963).

Deformation twins on $\{11\bar{2}1\}$ planes in zirconium appear to form by means of a different mechanism from twins on the same planes in other hexagonal materials. An adequate explanation of the crystallographic features of the Zr twins cannot be given in terms of conventional twinning modes and it is suggested that a double twinning process is responsible for their formation. The most likely mechanism is shown to be twinning on $\{11\bar{2}4\}$ followed by retwinning on $\{11\bar{2}4\}$. (auth)

31004 THE PHASE DIAGRAMS OF THE ALUMINIUM–RHENIUM AND ALUMINIUM–TECHNETIUM SYSTEMS. L. M. d'Alte da Veiga (Cambridge Univ., Eng.). Phil. Mag. (8), 8: 1241-5(July 1963).

A tentative phase diagram is given for the aluminium-rich end of the Re–Al system; it is based on both the present and previous investigations. A new phase $ReAl_4$ is reported; a relationship between its triclinic structure and the monoclinic structure of $MoAl_4$ is suggested. The probable similarity between the aluminium-rich sides of the phase diagrams of the Re–Al and Tc–Al systems is also indicated. (auth)

31005 ANOMALOUS THERMAL EXPANSION AND MAGNETOSTRICTION OF SINGLE CRYSTALS OF DYSPROSIUM. A. E. Clark, R. M. Bozorth, and B. F. Desavage (Naval Ordnance Lab., White Oak, Silver Spring, Md.). Phys. Letters, 5: 100-2(June 15, 1963). (In English)

Measurements showed very large magnetostrictive strains (about 6×10^{-3}) at temperatures near the Curie point. Anomalous thermal expansions were observed from above the Neel point, $\theta_N = 178°K$, to below the Curie point, $\theta = 85°K$; between these temperatures a spiral magnetic structure can be changed to a ferromagnetic structure by the application of a strong magnetic field. The appearance of orthorhombic structure due to magnetostrictive effects in the conversion to ferromagnetism resulted in no distortion of the thermal expansion curve at the Curie point in a magnetic field. The magnetostriction seems to predominate in determining the thermal expansion. (auth)

31006 MEASUREMENT OF YOUNG'S MODULUS OF ALPHA PLUTONIUM AT LOW TEMPERATURE. R. Lallement (CEN, Fontenay-aux-Roses, France). Phys. Letters, 5: 182-3(July 1, 1963). (In French)

The fundamental frequency of longitudinal vibrations in the sample was measured by a resonance method (described). Values of the Young's modulus at temperatures of 4.2 to 300°K were determined from the frequency. At 300°K a value of 9600 kg/mm^2 was found. The modulus plotted vs. temperature displayed a marked minimum between 50 and 60°K, indicating a single anomaly in the physical properties of Pu alpha in this region. A transition of magnetic origin seems to account most probably for the anomaly. (D.C.W.)

31007 X-RAY LINEWIDTHS OF NEARLY PERFECT COPPER CRYSTALS. M. C. Wittels, F. A. Sherrill, and F. W. Young, Jr. (Oak Ridge National Lab., Tenn.). Phys. Letters, 5: 183-5(July 1, 1963). (In English)

The half widths of reflections from successive orders of (111) in copper were determined using a double spectrometer. Rocking curve measurements were made using Cu crystals in both crystal positions and using perfect Si crystals in the first crystal position with Cu crystals in the second position. The results agree quite well with values calculated from the Darwin theory for perfect crystals. A marked narrowing in the (222) rocking curve was observed when a Si (333) reflection from the perfect first crystal and Cu (222) reflection in the parallel second crystal arrangement was used. (D.C.W.)

31008 METHOD OF QUANTITATIVE PHASE ANALYSIS OF ZrO_2 DIFFRACTOMETER URS-50 I. I. I. Vishnevskii, B. Ya. Sukharevskii, and A. M. Gavrish. Sb. Nauchn. Tr., Ukr. Nauchn.-Issled. Inst. Ogneuporov., No. 5(52), 315-23(1961).

A method of quantitative phase analysis was developed. A characteristic feature of the method is the use of a ring-shaped sample and the method of calculation which permits elimination of errors arising from the determination of the background scattering of the x-ray photograph. It was found that preliminary annealing at 800°C makes it possible to determine the amounts of the monoclinic modification independent of the magnitude of lattice distortion present before annealing and the grain size ($\leq 60\ \mu$). The error in the determination of the concentration in the chosen method depends on the content of the phase and is of the order of 1.5 to 5% absolute. (Referativnyy zhurnal, Khimiya, No. 11, 1962)

31009 RADIATION OF THERMAL ENERGY FROM REAL BODIES. R. J. Thorn and G. H. Winslow (Argonne National Lab., Ill.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 421-47(1962).

Thermal emission from solids is studied, with attention to equilibrium and nonequilibrium concepts, theory of emission (Kirchoff's law, Drude theory, anomalous skin effect, etc.), and measured emissivities of C, graphite, SiC, Si, Ti, Fe, Ni, Co, Ge, Zr, Mo, Ta, W, and Re. (T.F.H.)

31010 TANTALUM ALLOYS—SOME HIGH- AND LOW-TEMPERATURE PROPERTIES. F. F. Schmidt, E. S. Bartlett, and H. R. Ogden (Battelle Memorial Inst., Columbus, Ohio). 28p. (CONF-53-2).

From AIME Fall Meeting, New York, 1962.

Continuing tantalum alloy development studies were concerned with a more detailed investigation of promising binary, ternary, and more complex tantalum alloys containing Groups IV-A, V-A, VI-A, VII-A, and VII-A metal additions. A primary objective of these studies was to improve the elevated temperature strength of tantalum with minimum degradation of fabricability and low-temperature ductility by alloying. Several alloys were found to exhibit hot tensile strengths in the excess of 25, 15, and 10 ksi at 2700, 3000, and 3500°F, respectively, combined with excellent cryogenic toughness and ductility. Particularly outstanding in this respect are alloys in the system Ta-Mo-W. Ternary parameter curves describing hot-strength, low-temperature ductility, recrystallization temperature, weld ductility, and fabricability are presented for the Ta-Cb-V, Ta-Hf-W, Ta-Mo-Hf, Ta-Mo-V, Ta-Mo-W, and Ta-V-W systems. (auth)

31011 MAGNETIC SUSCEPTIBILITY OF NEODYMIUM-RICH NEODYMIUM-DYSPROSIUM SOLID SOLUTIONS. Sigurds Arajs, R. V. Colvin, and J. M. Peck (United States Steel Corp., Monroeville, Penna.). 8p. (CONF-20-15).

From 3rd Rare Earth Conference, Clearwater, Fla., Apr. 1963.

Magnetic susceptibilities of Nd and Nd-Dy alloys containing 5.5, 11.2, and 15.9 at. % Dy were measured from 300 to 1250°K. The alloy data can be approximately interpreted on the basis of the Van Vleck theory starting from the magnetic susceptibility of Nd and assuming that Dy in solid solution with Nd gives almost free tri-positive Dy ions. (auth)

31012 MATERIAL REQUIREMENTS FOR MAGNETOHYDRODYNAMICS. D. C. Goldberg, W. E. Young, and R. L. Hundstad (Westinghouse Electric Corp., Pittsburgh). 31p. (CONF-59-1)

From ASM Western Metal Congress, Los Angeles, Mar. 1963.

Physical, chemical, and electrical properties required of materials to be used for electrodes (conductors) and side walls (insulators) in magnetohydrodynamic (MHD) cells are discussed, and the results obtained in the evaluation of a number of materials using two generators and a simulator are presented. Of graphite, W, coated W, W alloys, Zr, ZrB, WB, and Zirconia cermet, ZrB showed the most promise as an electrode material. The refractory oxides and zirconates tested as insulators appear unusable under the required conditions. Development of superconducting magnets for MHD cells is briefly discussed. Ni-Zr seems best for this application. (D.C.W.)

31013 PROCESSES OF CREEP AND FATIGUE IN METALS. A. J. Kennedy, Wiley Series on the Science and Technology of Materials. New York, John Wiley & Sons, Inc., 1963. 490p. $12.00.

A fundamental and reasonably self-contained treatment of creep and fatigue is presented. The generalized physical response of materials to stress, structural theory at an atomic level, and dislocations are discussed. Creep and fatigue are examined separately and then brought together and considered under complex conditions of stress and temperature. Theoretical ideas and the actual behavior of materials in practical environments under applied conditions are compared. (C.E.S.)

31014 TUNGSTEN AND MOLYBDENUM. C. Agte and J. Vacek (National Aeronautics and Space Administration, Washington, D. C.). NASA Technical Translation F-135. Translation of "Wolfram a Molybden" Prague, State Publishing House of Technical Literature, 1954. 1963. 302p. $1.00(GPO).

The technical importance of both high-melting metals, tungsten and molybdenum, is examined. A discussion on the geologic distribution and world production of both metals is presented. Methods of extraction and production of ductile tungsten and molybdenum are described. The powder metallurgy and physical and chemical properties of both metals are described. The metallography, alloys, and technical applications of the two metals are presented. (C.E.S.)

31015 THE ELECTRICAL AND SUPERCONDUCTING PROPERTIES OF VACUUM DEPOSITED LEAD FILMS. Henry Elliott Vogel. Thesis, Chapel Hill, N. C., Univ. of North Carolina, 1962. 86p.

The superconducting transition temperature of vacuum-deposited Pb films was measured. A comparison is made between the film thickness as obtained from the known evaporation rate and time and the thickness as calculated from the measured slope of the film resistance vs temperature and the known slope of the bulk resistivity with temperature. The resistivity of the films as a function of thickness is compared to theoretically predicted values. Four films were deposited simultaneously on quartz substrates maintained at either 4.2 or 77°K in a cryostat, with subsequent annealing at 300°K. A shutter was used to produce a range of thicknesses among the 4 films. All of the films which were prepared proved to be superconducting with the transition temperature decreasing with thickness, the lowest transition temperature measured being 6.923°K for a film 112 Å thick. The transition temperature is increased by annealing, the change being inversely proportional to the film thickness with an increase of 240 millidegrees being the largest value observed. A rough estimate of the film thickness may be made using the shape of the annealing curves. The thinnest electrically continuous films which could be produced at 77°K contained enough Pb to make a uniform layer 80 Å thick and those produced at 4.2°K contained sufficient Pb for a uniform layer 110 Å thick. A comparison of the resistivity of these films with that predicted theoretically shows that surface scattering cannot explain the high values of resistivity observed. These very thin films are in the form of large clumps of atoms loosely connected so that the actual conducting path is only a few angstroms thick. One such Pb film was not electrically continuous but was shown to be superconducting by means of its tunneling behavior. Using the known potential required for one tunneling process, it was estimated that there were about 10^5 of these tunneling junctions in series allowing the tunneling current to travel across the 1.5 cm length of the film. (auth)

Radiation Effects

Refer also to abstracts 29896, 29900, 29920, 29925, 29926, 29927, 29928, 29933, 29934, 29966, 29967, 29968, 29969, 30122, 30127, 30128, 30129, 30130,

30131, 30133, 30134, 30204, 30205, 30208, 30209, 30825, 30826, and 30827.

31016 (AAEC/E-106) THE IRRADIATION BEHAVIOR OF BERYLLIUM OXIDE DISPERSION FUELS. G. L. Hanna, B. S. Hickman, and R. J. Hilditch (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Mar. 1963. 29p.

Specimens of beryllium oxide-based dispersion fuels containing between 3 and 26 vol % of UO_2-ThO_2 solid solution were irradiated to fission densities of 2 to 14 × 10^{19} fissions/cm^3 of total specimen (equivalent burnups of 80 to 230%) at temperatures of 600 to 850°C. The experiment was primarily designed to investigate fission product damage although some fast neutron damage did occur in the matrix. The specimens showed excellent resistance to fission product damage; dimensional changes were small, fission product escape was generally only that expected by recoil and there was no sign of cracking due to thermal stresses although these reached estimated values of about 30,000 psi in some specimens. Metallographic examination showed that some weakening of the matrix grain boundaries had occurred and some preliminary x-ray results suggested that the matrix was in a state of strain. It is suggested that these effects could be due either to fast neutron damage in the matrix or swelling of the fuel particles. The experiment did not provide any conclusive evidence for the superiority of coarse fuel particles (100 to 180μ) over fine fuel particles (<10μ) although the dimensional changes and the degree of matrix strain were higher in the latter specimens. (auth)

31017 (AAEC/E-108) ELECTRON MICROSCOPE STUDIES OF IRRADIATED BERYLLIUM METAL. J. H. Chute (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). May 1963. 25p.

When beryllium is irradiated by fast neutrons, helium is produced by the (n,2n) and (n,α) transmutation reactions. Electron microscopy techniques were used to study the nucleation and distribution of helium bubbles in several different grades of beryllium, after irradiation at temperatures in the range 75 to 700°C. The effect of post-irradiation annealing is also reported. It is shown that for similar neutron doses and irradiation temperatures, there were wide variations in helium bubble size and distribution in specimens of beryllium fabricated by different methods. The most satisfactory material was that fabricated from Pechiney powder by direct hot extrusion followed by annealing for one hour at 800°C and air cooling. It is suggested that the helium bubbles nucleate on second phase precipitates and that the distribution of this phase is strongly affected by fabrication and heat treatment. (auth)

31018 (CEA-2241) MESURE DE L'ENERGIE EMMAGASINEE PAR LE GRAPHITE IRRADIE. (Measurement of Stored Energy in Irradiated Graphite). P. Gelin, J. Rappeneau, C. Bruneton, and M. Quetier (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962.

A method was developed for measuring the stored energy of irradiated graphite by semi-adiabatic annealing. The principle consists in placing a sample in an enclosure whose temperature increases as a function of the depth of the sample. When the sample of irradiated graphite releases its energy "spontaneously," it is placed at each moment at a point in the enclosure which is at the same temperature. The graphite thus attains a temperature θ fairly close to that which would correspond to an adiabatic reaction. The comparison of the amounts of energy measured by differential thermal analysis and by semi-adiabatic annealing on samples of graphite irradiated in similar conditions, is satisfactory. This method makes it possible to measure rapidly the energy which can be released "spontaneously" from irradiated graphite. As a result, it is particularly suitable for the study of the maximum temperatures (adiabatic conditions) which could be produced by the energy liberation during the annealing of the graphite stack of a reactor. (auth)

31019 (GA-4267) FISSION-PRODUCT RELEASE FROM "SINGLE-CRYSTAL" UC_2 PARTICLES. L. R. Zumwalt, P. E. Gethard, and E. E. Anderson (General Atomic Div. General Dynamics Corp., San Diego, Calif.). June 5, 1963. Contract AT(04-3)-167. 36p. (CONF-39-2)

From American Nuclear Society Annual Meeting, Salt Lake City, June 1963.

The fission-product release of spherical single-crystal UC_2 particles was studied by means of postirradiation annealing of neutron-activated samples and by exposing samples to a steady rate of photofission, using 30-Mev x rays. The release of the several fission products studied appeared to follow the kinetics and temperature-dependence of an activated diffusional process. The anomalous fast release of a portion of the Xe^{133} in annealing experiments may be interpreted as being due to release of attached or trapped xenon atoms by a process not following Fick's law (i.e., by a nondiffusional process). Analysis of the data obtained gives the following diffusion coefficients for krypton, tellurium, iodine, xenon, and barium in UC_2 (in cm^2/sec): $D_{Kr} = (6.2 \times 10^{-5})\exp(-44{,}000/RT)$ from steady-state release, $D_{Te} = (1.26 \times 10^{-5})\exp(-67{,}000/RT)$ from annealing experiments, $D_I = (4.1 \times 10^{-6})\exp(-53{,}300/RT)$ from annealing experiments, $D_{Xe} = (4.6 \times 10^{-6})\exp(-68{,}000/RT)$ from the slow component, and $D_{Ba} = (2.0_4 \times 10^{-7})\exp(49{,}000/RT)$ from annealing experiments. The diffusion coefficient for xenon in UC_2, expressed by the equation $D = D_0 \exp(-Q/RT)$, showed remarkable agreement, both as to D_0 and Q (the activation energy for diffusion), with the diffusion coefficient for xenon in UO_2 selected by Lustman. A negative activation entropy (−13 eu) for diffusion was found from D_0. (auth)

31020 (GEAP-3743(Pt.I)) RADIATION EFFECTS IN BORIDES. PART I. HELIUM RELEASE AND SWELLING IN IRRADIATED BORIDES. E. W. Hoyt and D. L. Zimmerman (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Feb. 13, 1962. Contract AT(04-3)-189. 44p.

The effects of reactor irradiation on boron and some binary borides irradiated to boron-10 burnups up to 99% are being studied. The borides were irradiated as fine powders, as dense self-bonded polycrystalline bodies, and in one case as a single crystal. Gas release, changes in volume and appearance, lithium migration, metallography, and hardness changes are discussed. (M.C.G.)

31021 (NP-12962) MOLECULAR CHANGES IN POLYAMIDE AND ELASTOMERIC POLYMERS DUE TO NUCLEAR, ULTRAVIOLET AND THERMAL RADIATION. Progress Report No. 7, December 16, 1962–June 15, 1963. G. Hargreaves (Naval Air Material Center. Aeronautical Materials Lab., Philadelphia). 17p.

Activities in an investigation to determine the molecular changes in polyamide and elastomeric polymers caused by nuclear, ultraviolet, and thermal radiation are reported. Some effects of gamma and ultraviolet irradiation in air, N_2, and in a vacuum on nylon 66 and an experimental fiber

HT-1 are shown by means of infrared spectra. Some discussion and interpretation of results are given. Plans for future work are discussed. (auth)

31022 EFFECTS OF PRELIMINARY ELECTRON IRRADIATION ON THE YIELD STRENGTH OF ZINC COATED BY LOW MELTING EUTECTICS. O. A. Troitskii, P. Ya. Glazunov, and V. I. Likhtman (Inst. of Physical Chemistry, Academy of Sciences, USSR). Fiz. Metal. i Metalloved., 15: 534-7(Apr. 1963). (In Russian)

Radiation effects on Zn–Sn, Zn–Cd, and Zn–Pb coated polycrystalline zinc were studied at 20, 200 to 220, and -196°C. The yield strength of Zn–Sn coated specimens at low temperatures and at 20°C increased about 15%. Irradiation at the eutectic melting point increased the strength about 40%. A much weaker effect was observed with zinc specimens coated with Zn–Cd and Zn–Pb eutectics. (tr-auth)

31023 RADIATION EFFECTS ON K-STATE IN NICHROME. Sh. Sh. Ibragimov and V. D. Dmitriev. Fiz. Metal. i Metalloved., 15: 621-2(Apr. 1963). (In Russian)

Effects of neutron bombardment on Ni–Cr alloy (21.4 wt % Cr) were studied using a specimen exposed to an integral dose of 1.26×10^{20} n/cm^2 during 1200 hours at 220 to 250°C. The results showed an improved electric resistance and microhardness. (R.V.J.)

31024 EFFECTS OF ELECTRON AND α IRRADIATION ON MICROHARDNESS OF ZINC AND CADMIUM ALLOYED BY TIN. O. A. Troitskii, I. M. Kuleshov, and V. I. Likhtman (Inst. of Physical Chemistry, Academy of Sciences, USSR). Fiz. Metal. i Metalloved., 15: 628-31 (Apr. 1963). (In Russian)

Studies of electron irradiation of Zn, Cd, Zn–Sn, and Cd–Sn microhardness at 20°C showed a considerable increase in Zn–Sn (40%) and Cd–Sn (17 to 15%) microhardness. The results of α irradiation of the specimens for 30 days at 20°C showed an increase in microhardness especially in Zn–Sn. (R.V.J.)

31025 THE EMISSION OF ELECTRONS FROM THE SURFACE OF RADIO CERAMICS IRRADIATED BY GAMMA RAYS. A. M. Belonogov and A. A. Yevgrafov. Izv. Leningr. Elektrotekhn. Inst., No. 46, 344-5(1961).

The results of an investigation on low-temperature electron emission from the surface of dielectrics subjected to ionizing radiation are presented. To record the emission, a specially developed installation with an open-type point counter working under atmospheric pressure was used. The intensity of the emission counting at 360°C was ~1000 pulses/sec (the natural background is 1 to 2 pulses/sec). When irradiating titaniferous ceramic materials by γ rays, an emission maximum was observed, corresponding to an emission peak at 360°C from the surface of a partially recovered rutile (an emission peak was also observed in the case of Ti-ceramics subjected to aging in the electric field). It is shown that the ceramics with a strongly expressed trend to age in the electric field had its emission peak at 140°C. More resistant ceramics have no such peak. An emission was observed in all cases at temperatures of ~450°C. It is pointed out that recent data speak in favor of the recombination nature of the phenomenon. (TCO)

31026 STRESS-STRAIN BEHAVIOR OF IRRADIATED POLYURETHANE ELASTOMERS. E. G. Fritz and Peggy M. Johnson (General Dynamics Corp., Fort Worth, Tex.). J. Appl. Polymer Sci., 7: 1439-50(July 1963).

The applicability of the Martin-Roth-Stiehler stress-strain relationship to a number of reactor-irradiated (gamma-ray dose range 0 to 1.9×10^{10} ergs/g in carbon) polyurethane elastomers was demonstrated. For each level of dose and irradiation temperature, the stress-strain values showed remarkably good agreement with the behavior predicted by this relationship, thus permitting a realistic characterization of the stress-strain curves up to extension ratios of 3 by two parameters: the tangent modulus E_0 and a coefficient K. While the available data did not justify conclusive inferences regarding the explicit nature of the functions $E_0(D)$ and K(D), it appears from this analysis that E_0 varies exponentially with dose D and that K is a slowly varying function of dose. (auth)

31027 INTEGRAL EQUATIONS GOVERNING RADIATION EFFECTS. (NOTES ON ATOMIC COLLISIONS, III). J. Lindhard, V. Nielsen, M. Scharff, and P. V. Thomsen. Kgl. Danske Videnskab., Selskab, Mat. Fys. Medd., 33: No. 10, 1-42(1963). (In English)

A theoretical study is made of damage effects by particle radiations in matter, and their dependence on energy, mass, and charge number of an incoming particle, as well as on the composition of the medium. Typical examples of damage effects are the number of ion pairs formed in a gas, or the number of vacancies created in a crystal. The study is particularly concerned with the consequences of the competition between energy transfer to atomic electrons and to translatory motion of an atom as a whole. For these purposes, common integral equations are formulated and studied. The study treats primarily average effects resulting from an atomic particle with given energy, but also their average fluctuation and probability distribution. As an important example, the division of the total energy dissipation, E, into energy given to recoiling atoms, ν, and energy given to electrons, $E-\nu$, is studied. Several radiation effects are accounted for from knowledge about E and ν. The primary quantities in a study of radiation effects are the cross sections for all relevant collision processes. Comprehensive estimates of cross sections are used, derived elsewhere in a Thomas-Fermi treatment. Various simple approximations are introduced; analytical and numerical estimates are made of solutions to the integral equations. For many purposes, nuclear collisions and electronic collisions may be treated as if they were unconnected events, although this is not quite correct, especially at low energies. Considerable simplification is obtained by a suitable scaling of energy. A key to a common experimental and theoretical study is provided by an incoming particle identical with the atoms of the substance. Only few experiments can at present be compared quantitatively with theory. (auth)

31028 TEMPERATURE DEPENDENCE OF IRRADIATION DAMAGE TO POLYTHENE. G. Todd and G. A. Wild (War Office, Royal Armament Research and Development Establishment, Fort Halstead, Sevenoaks, Eng.). Nature, 199: 172(July 13, 1963).

Comparison of measurements of radiation damage to polythene exposed to a 4.3-Mev linear accelerator and in a reactor led to the conclusion that radiation damage of polythene is temperature dependent. Applications of radiation in raising or lowering the elastic modulus of polythene are suggested. (C.H.)

31029 FISSION FRAGMENT DISTRIBUTION IN IRRADIATED UO_2. R. M. Berman (Bettis Atomic Power Lab., Pittsburgh). Nucl. Sci. Eng., 16: 315-28(July 1963). (WAPD-T-1554)

Four irradiated UO_2 samples were ground to break them

along grain boundaries, then dissolved in a series of successive leaches with 3N HNO_3. The successive acid extractions were then analyzed for Cs^{138}, Ce^{144}, Zr^{95}, Sr^{90}, and Eu^{155}, as well as total uranium. Considerable variation in the specific activities of the fission fragments was found between one acid extraction and another, in the same sample. The fission products were concentrated in the first and last portions of the material to dissolve. In one sample, which underwent irradiation for a very short time, the increase in concentration in the last portion to dissolve was not observed. It was speculated, on this and other evidence, that fission fragments did not remain in solid solution in uranium dioxide, but migrated to grain boundaries and other lattice defect sites. (auth)

31030 THE FORMATION OF DEFECT CLUSTERS IN ALUMINIUM BY ION BOMBARDMENT. C. J. Beevers (Central Electricity Generating Board, Berkeley, Glos, Eng.), and R. S. Nelson. Phil. Mag. (8), 8: 1189-1202 (July 1963). (AERE-R-4300)

Pre-thinned foils of aluminium were bombarded by 85-kev H^+, He^+, Ne^+, A^+, Kr^+ and Xe^+ ions. Electron microscope observations showed that the formation of point defect clusters in these foils is dose rate dependent. In foils bombarded by H^+ ions, the number of observable point defects increased with increasing dose, whereas the total number of clusters and loops decreased. This is attributed to the mobility and interaction of loops during bombardment. The number of observable point defects was much greater after bombardment by Xe^+, Kr^+ and A^+ ions than after the same dose of He^+ or H^+ ions. These observations are explained in terms of simple displacement theory. (auth)

31031 DECOMPOSITION OF CALCIUM FLUORIDE AND STRONTIUM FLUORIDE IN THE ELECTRON MICROSCOPE. T. Evans (Univ. of Reading, Eng.). Phil. Mag. (8), 8: 1235-40(July 1963).

Thin fragments of calcium fluoride and strontium fluoride crystals were prepared that were suitable for examination by transmission electron microscopy. After a short irradiation by the electron beam, Moiré patterns appear and these are attributed to the partial decomposition of the fluorides, resulting in the formation of metallic calcium or strontium in a parallel orientation to the undecomposed fluorides. After further irradiation the patterns become diffuse and eventually disappear. (auth)

31032 EFFECTS OF HIGH PRESSURE ON THE THERMOLUMINESCENCE OF γ-IRRADIATED α-Al_2O_3 SINGLE CRYSTALS. A. F. Gabrysh, J. M. Kennedy, H. Eyring, and V. R. Johnson (Univ. of Utah, Salt Lake City and Univ. of California, Los Angeles). Phys. Rev., 131: 1543-8(Aug. 15, 1963).

Thermoluminescent properties are reported on γ-irradiated α-Al_2O_3 and ruby single crystals, before and after the specimens were subjected to hydrostatic pressures of 24 kbar for 255 min at 773°K and at 30 and 40 kbar for 30-min periods at room temperature. Glow-curve changes and peak resolutions occur for white sapphire in the temperature range of 340 to 623°K. The graphs show regularity with regard to glow-peak temperatures and their sensitivity to higher annealing temperatures after pressure. A single pressure-sensitive peak at ~503°K appears in ruby after applying pressure or after γ irradiation. Activation energies for several peaks as calculated from the results are also given. (auth)

31033 CROSS-LINKING OF POLYMERS BY RADIATION. George Adler (Brookhaven National Lab., Upton, N. Y.). Science, 141: 321-9(July 26, 1963).

Cross-linking is a process of considerable commercial as well as biological importance. It gives useful properties to a wide variety of polymers; some, such as rubber, would be almost useless if it did not occur. The facilitation of cross-linking for commercial purposes, however, usually entails the use of heat or certain additives, or both. These agents sometimes alter certain of the properties of the polymer disadvantageously. Radiation can bring about cross-linking without the use of heat or additives. In addition, it can do this in polymers in which it is difficult to bring about cross-linking by other means. Unfortunately, the G value for crosslinking, which is a measure of the process efficiency, is usually so low that relatively large radiation doses are needed. This makes the technique still economically unattractive. The use of certain types of additives sharply increases the G values in some instances, but these additives are in themselves relatively expensive. In addition, some of the materials in which cross-linking is produced by radiation seem to have poorer mechanical properties than equivalent materials in which it is produced chemically. Despite the production of a certain amount of polyethylene in which cross-linking has been brought about by radiation, realization of the commercial promise of this process seems to be far in the future. The large amount of work in this field has resulted in a better understanding of both polymers and radiation chemistry. (auth)

31034 RADIATION RESISTANCE OF FOAMED GLASS. S. M. Brekhovskikh and E. Z. Zhitomirskaya. Steklo i Keram., No. 5, 16-17(May 1963).

The radiation resistance of two types of foamed glass was studied. The first type was prepared from 90 to 95% alkali window glass (71.5% SiO_2, 1 to 1.5% Al_2O_3, 7.5 to 8% CaO, 3 to 3.5% MgO, 15% Na_2O) and 10 to 5% Al_2O_3, TiO_2, or ZrO_2, with the addition of 0.5 to 1% SiC or carbon black, or 4% MnO as foaming agents. The second type was prepared from 70 to 80% nonalkali barium glass (60.5% SiO_2, 14.6% Al_2O_3, 16.2% CaO, 8.7% BaO, +2% Fe) and 30 to 20% Cr_2O_3 or ZrO_2, with the addition of 0.5 to 1% SiC or carbon black. The approximate service temperature of the glasses is 600 to 800°C; the highest compressive strength, 31.7 to 74.4 kg/cm^2, is exhibited by specimens produced with the use of SiC. The glasses were irradiated with thermal neutrons for 84 hr (total flux about 10^{18} neutrons/cm^2) and subjected to compression tests. The tests showed that the mechanical strength of the specimens remained almost unchanged. It was concluded that foamed glasses from alkali window glass and TiO_2 or ZrO_2 and from nonalkali Ba glass with Cr_2O_3 or ZrO_2 are resistant to radiation and can be used as heat-resistant thermal insulation in equipment exposed to gamma-neutron radiation. (OTS)

31035 THE MECHANISM OF THERMAL DECOMPOSITION OF IRRADIATED SOLIDS. V. V. Boldyrev. Tr. 2-go [Vtorogo] Vses. Soveshch. po Radiats. Khim., Akad. Nauk SSSR, Otd. Khim. Nauk, Moscow, 1960, 42-7(1962).

The effects of various types of radiation on the subsequent thermal decomposition of solids are described. It is suggested that the effect of irradiation with low energy γ quanta or electrons on subsequent thermal breakdown can be explained by the formation of small included regions of a new phase that can act as initiating centers for subsequent decomposition. The active centers are similar to those produced by preliminary heating or irradiation with light, except that irradiation with γ quanta or electrons produces active centers throughout the body of the solid and not just on the surface; therefore, the effect of irradiation with γ quanta or electrons on the kinetics of the

subsequent thermal decomposition will be far greater than that of preliminary heating or irradiation with light. (TCO)

31036 ENHANCED NUCLEATION OF RADIATION DAMAGE IN GRAPHITE. W. N. Reynolds and P. A. Thrower (Atomic Energy Research Establishment, Harwell, Berks, Eng.). (CONF-73-1)

From Sixth Biennial Conference on Carbon, Pittsburgh, June 1963.

The homogeneous nucleation theory of radiation damage in graphite suggests that interstitial atoms collect into clusters on a scale dependent on the temperature of the graphite and the damage flux to which it is exposed. Experiments were conducted involving short irradiations (6 hours to 6 days) in a materials testing reactor at a lower temperature (~150, 200, or 350°C) followed by several months' irradiations at a higher temperature (350 or 650°C). The long term nucleation pattern was shown by transmission electron microscopy to be profoundly modified by the short initial treatment, and the total rate of accumulation of interstitial atoms is considerably increased. The effects of the enhanced nucleation on macroscopic properties were demonstrated by comparative measurements of dimensional changes and thermal resistivity increases during 350°C irradiation of specimens seeded at 150°C. (auth)

31037 TRANSIENT RADIATION EFFECTS IN SIMPLE TRIODE AMPLIFIERS. P. A. Trimmer (Army Material Command, Washington, D. C.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1081, 7p, $1.00. (CONF-1-19)

From Summer Meeting, Toronto, June 1963.

Transient radiation effects data on simple triode amplifiers were obtained for gamma radiation exposure rates varying from 1×10^5 to 1×10^7 r sec^{-1}. From the observed transient output voltages, equivalent input currents were calculated. These currents were approximately 7×10^{-13} amps $sec\ r^{-1}$ in amplifiers potted in silastic and from 3 to 7 times this amount in unpotted amplifiers. The polarity of the observed voltages indicated that positive voltages were generated in the grid circuit. (auth)

31038 SPIN 1 CENTERS IN NEUTRON IRRADIATED SILICON. Jung Wun and G. S. Newell (Purdue Univ., Lafayette, Ind.). 61p. (CONF-23-7).

From American Physical Society Meeting, St. Louis, Mar. 1963.

Electron paramagnetic resonance was used to identify a number of fast-neutron induced defects formed in pile-irradiated Si and to follow their concentrations as a function of annealing. Measurements were made at 300, 77, and 4.2°K on samples that had attained intrinsic resistivity during irradiation, using superheterodyne spectrometers operating at 24 kMc and 9.4 kMc. Aside from the Si-N center, the most prominent lines of the spectrum arise from the $m_s = 0$ to ± 1 transitions of four spin 1 systems. The distinct symmetry and small production rate (≈0.05 centers per fast neutron collision) indicate a class of well-defined but relatively rare defects. Their g tensors, zero-field splitting tensors, and hfs are compatible with systems having two weakly interacting (1 1 1) dangling bonds separated by about a lattice spacing, giving the S = 1 Hamiltonians in the triplet levels formed by the weak exchange interaction. Low-temperature measurements suggest that the singlet-triplet splitting lies between 3 and 50 cm^{-1}. Comparison with floating zone Si shows Center (11, 111), which is dominant in unannealed samples, to be independent of impurity. The remaining three S = 1 centers, which grow and decay rapidly at higher temperatures, involve O. Precise measurements of the parameters of the spin Hamiltonians are given to permit reproducible identification of the centers. (auth)

31039 TRANSIENT RADIATION EFFECTS ON A TRANSISTORIZED SYNC GENERATOR. Joseph A. Costantino (Frankford Arsenal, Philadelphia). New York, Institute of Electrical and Electronics Engineers, 1963. Preprint 63-1120, 14p, $1.00. (CONF-1-3)

From Summer Meeting, Toronto, June 1963.

A fully transistorized sync generator was subjected to bursts of radiation from a Triga Mark F pulsing reactor operated by the Diamond Radiation Facility. This reactor is capable of producing pulsed radiation levels of 2.9×10^{12} neutrons/cm^2 (above 3 Mev) and 1.0×10^5 r gamma for a half-power period of 12 milliseconds at a location approximately 40 cm in front of the core center. The sync generator was in operation at the time of irradiation. Information concerning the operating of the sync generator was monitored before, during, and after each radiation pulse. This information consisted of observations of the waveforms produced by the sync generator. It was noted that the sync generator was inoperative during a brief period of time which began with the radiation pulse and ended approximately two seconds after. A slight distortion in the waveforms was then noticeable, but performance was otherwise normal and the sync generator was considered to be operating satisfactorily. Pulsed irradiation of the sync generator was continued until the circuitry was permanently damaged. This occurred at a total neutron dosage of 7.3×10^{12} neutrons/cm^2 (above 3 Mev) and a total gamma dosage of 3.2×10^5 r. The sync generator was removed from the reactor pool and returned to the laboratory for analysis after sufficient time for "cooling off" had been allowed. Subsequent examination revealed that the transistors had suffered permanent damage in the form of a loss of gain. In some cases, the gain was reduced to approximately 20% of its original value. (auth)

31040 GAMMA-RAY AND NEUTRON-INDUCED CONDUCTIVITY IN INSULATING MATERIALS. S. E. Harrison, F. N. Coppage, and A. W. Snyder (Sandia Corp., Albuquerque, N. Mex.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint Paper CPA 63-5156, 30p, $1.00. (CONF-4-2)

From Electro-Nuclear Conference, Richland, Wash., May 1963.

Excess conductivities induced by steady-state sources of gamma rays and by pulsed sources of neutrons and gamma rays in polyethylene, polystyrene, polypropylene, nylon, polyisobutylene (impregnated paper), mylar, teflon, diallylphthalate, H-film, cellulose acetate, reconstituted mica, tantalum oxide, and an epoxy formulation were measured. The measurements were made at steady-state gamma-ray dose rates within the interval from 1.0×10^{-3} rads (H_2O)/sec to 1.0×10^4 rads (H_2O)/sec, and at combined pulsed-neutron and gamma-ray dose rates less than 2.0×10^8 rads (H_2O)/sec. All measurements were made at controlled temperatures between 25 and 71°C. With steady-state gamma-ray irradiation, an excess conductivity is induced which has distinct features in three time intervals denoted as A, B, and C. In interval A, induced conductivity $(\sigma - \sigma_0)$ is responding to a step increase in gamma-ray dose rate. The conductivity response is exponential $(\sigma - \sigma_0) = A(1 - e^{-t/\tau_0})$, with the time constant (τ_0) decreasing with increased gamma-ray dose rate $(\dot{\gamma})$.

The change in time constant as a function of gamma-ray dose rate at a fixed temperature is approximated by $\tau_0 = k_0\dot{\gamma}^{-\mu}$, where k_0 and μ are empirical constants. In interval B the induced conductivity has arrived at an equilibrium value whose magnitude as a function of gamma-ray dose rate at a fixed temperature is characterized to a good approximation by $(\sigma - \sigma_0) = A_\gamma \dot{\gamma}^{\delta}$, where A_γ and δ are empirical constants. In interval C the conductivity is recovering upon removal of the sample from the radiation environment. The measured, induced conductivity decay is characterized by $\sigma = \sigma_{eq} \sum_{i=1}^{n} k_i e^{-t/\tau_i}$, where σ_{eq} is the equilibrium conductivity of interval B, the τ_i's are discrete decay time constants of the recovery, the coefficients k_i are the weighting factors associated with the i^{th} decay time constant, and n is the number of discrete decay time constants in the recovery process. The equilibrium-induced conductivity of interval B is thought to contain two components. One component arises from direct excitation of carriers to conducting states by the irradiation; the second component arises from thermal excitation of trapped carriers (non-conducting states) to conducting states. It is the influence of the release of the trapped carriers that dictates induced conductivity response and induced conductivity decay. This influence, although present in steady-state gamma-ray-induced conductivity, is not present in transient-induced conductivity from pulsed-irradiation sources. For the transient case, the induced conductivity is measured to be in "transient equilibrium" with the pulsed-irradiation sources. The relationship which defines induced conductivity, as a function of dose rate ($\dot{R}$), from a combined neutron and gamma-ray pulsed source is $(\sigma - \sigma_0) = A_{n\gamma} \dot{R}^{\delta}$. The value of $A_{n\gamma}$ is measured to be less than A_γ. The difference in the magnitude of A is attributed to the trap component of excess conductivity, which exists only under steady-state irradiation, and to the relative effectiveness of neutrons and gamma rays in producing induced conductivity. The effectiveness per unit dose rate (rads(material)/sec) of neutrons relative to gamma rays in producing induced conductivity was determined for two materials. The data reveal that the ratio between the effectiveness of neutrons and the effectiveness of gamma rays in producing induced conductivity is 0.044 for polyisobutylene (paper) and 0.23 for polystyrene. (auth)

31041 CHARGE-CONTROL EQUIVALENT CIRCUIT FOR PREDICTING TRANSIENT RADIATION EFFECTS IN TRANSISTORS. C. R. Rosenberg (Boeing Co., Seattle), D. S. Gage, R. S. Caldwell, and G. H. Hanson. New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1018, 17p, $1.00. (CONF-1-15)

From Summer Meeting, Toronto, June 1963.

By the use of this charge-control model and a set of electrical and pulsed radiation measurements which are used to determine the values of certain basic parameters, it is possible to predict a circuit's behavior in any transient radiation environment with a fair degree of success. There is no reason to expect that the above approach is limited to the transistor types used as examples although there are other important types which have not yet been investigated. Although the current dependence of the parameters and the behavior in saturation are both provided for in the present model, these two areas must be given additional study. (auth)

31042 MATHEMATICAL MODELS FOR RELIABILITY TESTING IN A NUCLEAR RADIATION ENVIRONMENT. T. Johnson (Chance Vought Corp., Dallas). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1079, 7p, $1.00. (CONF-1-11)

From Summer Meeting, Toronto, June 1963.

For the present, at least, the reliability of equipments operating in a nuclear radiation environment must be estimated from the results of past small sample experiments or from program peculiar experiments which practicality dictates must also be of small sample size. In general the present state-of-the-art hardly justifies the assumption of any specific Weibull shape parameter, k, greater than unity. Also, when one considers the manner in which this parameter, k, sometimes appears to change with test time, the dangers of extrapolation of test results become clear. Thus for the high reliabilities of concern in modern programs, the assumption of exponential failure should be used unless there is firm justification for establishing a greater lower bound on the Weibull shape parameter, k. (auth)

31043 AN EXPERIMENTAL INVESTIGATION OF NUCLEAR RADIATION EFFECTS ON RADAR RECEIVER COMPONENTS. W. D. Bristow, Jr., B. T. Lowrey, C. A. Robson, and G. D. Wyers (Chance Vought Corp., Dallas). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1073, 15p, $1.00. (CONF-1-10)

From Summer Meeting, Toronto, June 1963.

As a result of this test effort, it may be concluded that practical i-f amplifiers may be fabricated for useful operation in a severe nuclear radiation environment. Although the amplifiers tested were not optimized for noise figure, no radiation-induced changes in noise figure were detected. Neither gain nor bandwidth were appreciably affected by the radiation environment. As anticipated, the radiation environment caused deterioration of the performance of the microwave mixer-preamplifier. Failure of the mixer diodes did not occur until well after the predicted limiting exposure of 9×10^{14} neutrons/cm^2. Failure occurred after an exposure of 4×10^{15} neutrons/cm^2; however gradual deterioration of the overall gain was noticeable early in the test. It is assumed that none of this degradation occurred in the preamplifier, but rather resulted from a gradual increase in the conversion loss of the mixer. Noise figure degradation was not apparent until after failure of one of the mixer diodes, and then degradation was gradual. Although the mechanics of these degradations are not understood, the effects corroborate earlier experiments showing that current semiconductor devices are inadequate for use in this environment. Thus, a definite requirement was established for the development of a mixer or downconverter capable of reliable operation in the environment of a nuclear-powered vehicle. (auth)

31044 EVALUATION AND COMPENSATION OF DIGITAL SWITCHING CIRCUITS IN TRANSIENT RADIATION ENVIRONMENTS. Stephen R. Sedore (International Business Machines Corp., Owego, N. Y.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1085, 14p, $1.00. (CONF-1-17)

From Summer Meeting, Toronto, June 1963.

The most serious effects that can be caused to a digital switching circuit by a pulse radiation environment can be categorized under two types: (a) Change in state of the output from OFF to ON. (Failure of the first type.) (b) Change in state of the output from ON to OFF. (Failure of the second type.) Failures of the first type are temporary in nature. This is true because they are caused by transient leakage currents. When there is no transient leakage current there can never be a failure of the first

type. Failures of the second type are essentially permanent in nature. They are caused by beta degradation of the circuit transistor which is predominantly a permanent effect. This statement must be qualified because evidence exists that some types of transistors experience a transient component of beta degradation. A switching circuit can be rated as to its degree of vulnerability to failures of the first type. This rating is expressed in units of current and can be considered as a figure of merit which can be used to predict circuit operation when the circuit is exposed to pulse radiation. Failure of the first type may surely and easily be prevented (up to a point) by a simple technique with no direct cost in quantity or types of hardware. However, the performance of the circuit when in the ON mode is impaired when this type of compensation is applied. This degradation of performance may be readily determined. Failure of the second type may not be prevented by compensation, since no means is possible to prevent beta degradation. An extra safety factor may be designed into the circuit, but this is not really compensation. Time durations of radiation bursts have much to do with switching circuit failures. A switching circuit may fail in a Godiva environment that would operate satisfactorily in a short duration burst of the same intensity. Other means of compensation are possible. Radiation sensitive components may be used or an additional path for the leakage current may be created by a circuit modification. (auth)

31045 POST-IRRADIATION RELIABILITY OF TRANSISTORS. L. B. Gardner and J. R. Coss (Northrop Space Labs., Hawthorne, Calif.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1057, 11p, $1.00. (CONF-1-8)

From Summer Meeting, Toronto, June 1963.

The results of a post-irradiation life-test of selected transistors are presented. These devices were exposed to steady-state mixed neutron and gamma radiation of approximately 3.3×10^{13} nv_et. A similar group of transistors was kept as controls. They were life-tested but not exposed to radiation. The results of the test show post-irradiation annealing of certain transistor parameters and the permanent radiation damage of other parameters. They also show the important role played by manufacturing processes with respect to the observed radiation damage and the annealing thereof. There is a statistically significant indication to show that one of the transistor types tested is failing. This was not, however, observed in the other type of transistor test, despite the fact that the silicon chip of both types were identically manufactured. The significance of this observation is discussed. (auth)

31046 DYNAMIC RADIATION EVALUATIONS OF PASSIVE COMPONENTS IN COMBINED ENVIRONMENTS. I. Doshay (Space-General Corp., El Monte, Calif.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-953, 17p, $1.00. (CONF-1-7)

From Summer Meeting, Toronto, June 1963.

Factorially designed experiments were devised to determine electrical performance characteristics of passive component parts under load while being exposed to various levels of gamma radiation and simultaneously in a vacuum. The experiment design includes sufficient samples, types, and load conditions for high confidence conclusions. Two useful mechanisms of ionizing radiation effects were discovered: (1) a bias effect which opposes ionizing radiation degradation; (2) a saturation effect which limits change in capacitance deviation and dissipation factor with respect to increase in dosage. A number of characteristics curves of radiation degradation for film resistors and solid tantalum capacitors are included. (auth)

31047 LOW ENERGY PROTON DAMAGE TO SOLAR CELLS. J. F. Weller and R. L. Statler (Naval Research Lab., Washington, D. C.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1184, 14p, $1.00. (CONF-1-1)

From Summer Meeting, Toronto, June 1963.

The effects of the nominal 5-Mev proton irradiation on solar cells can be summarized as follows: 1. The n/p silicon solar cell is more radiation-resistant than the p/n silicon solar cell. The n/p cell has a damage constant which is 1/10 of the p/n cell damage constant. An integrated flux of 10 times or more is required to produce equivalent damage. Differences in n/p cells can be correlated with base resistivity. 2. Oxygen impurity does not affect the recombination rate of minority carriers in 5-Mev proton-damaged silicon solar cells of both polarities. 3. There is a strong oorrelation between increased radiation resistance with increased bulk resistivity of the solar cell. 4. GaAs cells have a higher damage rate than silicon cells, after they once start to degrade; all of the carriers in these cells are collected from regions near to the junction, so that at very low proton energies the damage rate will be much greater. 5. Some annealing of the radiation damage will occur in all cells at room temperature. A dependency of diffusion length on the injection current level was not found. (auth)

31048 DESIGN AND TEST OF A NUCLEAR-RADIATION TOLERANT SERVO AMPLIFIER. J. R. Scarborough, B. E. Johnson, and R. Nelson (Chance Vought Corp., Dallas). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1174, 20p, $1.00. (CONF-1-4)

From Summer Meeting, Toronto, June 1963.

A servo amplifier was designed to meet the nuclear radiation environment expected in the nuclear ramjet missile. An extensive search of radiation effects data was made to judiciously select radiation resistant components and materials. The resulting design used RCA nuvistor tubes for voltage amplification, and power amplification was achieved with G.E. ceramic tubes. The amplifier was instrumented to evaluate individual stage performance. Irradiation testing was conducted over a 130-hour period and the unit was subjected to an integrated fast neutron flux of 2.0×10^{17} neutrons/cm^2 (E > 0.3 Mev) and an associated gamma dose of 2.5×10^{11} ergs/gm-(C). The servo amplifier operated throughout the test with negligible changes in amplifier characteristics. (auth)

31049 SOME EFFECTS OF TRANSIT GAMMA RADIATION ON TRANSISTORS. H. A. Zagorites (Naval Radiological Defense Lab., San Francisco), D. Y. Lee, E. A. Carr, and C. F. Ramstedt. New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1066, 19p, $1.00. (CONF-1-14)

From Summer Meeting, Toronto, June 1963.

Based on the simulated transit environment used in this study and other assumptions made, the following conclusions are apparent from the results obtained. (1). The observed effects for all transistor types were mainly of a temporary nature, with recovery usually occurring within a few hours after radiation exposure. The observed temporary fractional I_{co} increases in the PNP germanium transistors tested were greatest in the high alpha cut-off frequency transistors. (2) Silicon transistors tested generally were affected less by gamma radiation than were

the germanium types, with some silicon types showing almost no radiation induced changes. (3) The large range in the magnitude of radiation effects sometimes produced within one transistor type suggested that the main causal phenomena were associated with surface variations rather than bulk variations between transistors. This conclusion is strengthened by the fact that all tests with no biases applied to the transistors, resulted in no measurable radiation-induced changes. On the other hand, large parameter changes were measured with biases applied to the same transistors, suggesting that charge collection from ionization on or near the junction surfaces may be taking place under the influence of the applied potentials. Additional work will be required to verify this hypothesis. (4) In general, the results indicated that the behavior of an individual transistor in a transit environment, as simulated in these tests, cannot be satisfactorily predicted from any pre-irradiation measurements or even from measurements taken at lower radiation levels. At present, the most fruitful approach to the problem of reliability appears to be conservative circuit design and the use of transistors manufactured to be radiation-resistant. Such an approach would require further study of the basic mechanisms causing the radiation-induced changes observed and evaluation of transistor manufacturing techniques with the view of improving performance during irradiation. (5) The magnitude of the transistor changes observed indicates a high probability for satisfactory performance of conservatively designed circuits. However, the possible effects of these changes on reliability are such that the military electronic designer cannot afford to ignore them. (auth)

31050 EFFECTS OF CHARGED PARTICLES AND NEUTRONS ON MAGNETIC MATERIALS. D. I. Gordon and R. S. Sery (Naval Ordnance Lab., Silver Spring, Md.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-950, 14p, $1.00. (CONF-1-5)

From Summer Meeting, Toronto, June 1963.

A review is presented of data gathered from 1959 to date. There is a growing interest in the effects of radiation on the properties of magnetic materials, with greater activity abroad (on both sides of the Iron Curtain) than in the United States. While several of the papers are extensive in nature, reporting results on a variety of materials, the trend is toward more intensive investigations of selected materials, with the goal of identifying more exactly the nature of the radiation induced damage. Pure metals, as well as order-disorder type alloys, are of particular interest. While many results have been reported, most conclusions to date concerning the nature of defects are indefinite. From the technological point of view, the thresholds of permanent damage due to long-term neutron (reactor) irradiation have been established for most types of soft and hard magnetic materials. Permanent effects of atomic explosion radiation on some typical soft materials have also been covered. Very little however has been reported to date on transient effects resulting from pulsed neutron radiation. Reports of charged particle effects on magnetic properties to date have been preliminary in nature. The authors' new data on the recovery of magnetic properties of iron and 5-79 Mo Permalloy irradiated to 10^{17} protons/cm^2 (1.5 Mev) show that the pre-irradiation properties of iron can be restored at relatively low annealing temperatures. Restoration of the Permalloy properties, which depend on more critical annealing schedules, could not be achieved at these temperatures. (auth)

31051 TRANSISTOR RELIABILITY AFTER RADIATION EXPOSURE. Leonard B. Gardner and James R. Coss (Northrop Space Labs., Hawthorne, Calif.). 5p. (CONF-58-1)

From Institute of Electrical and Electronics Engineers International Convention, New York, Mar. 1963.

A study was made on the effects of irradiation on the mean time to failure of 20 transistors, using reactor radiation and stopping the irradiation when the β/β_0 of one of the transistors reached 0.7. Life tests were then conducted on the irradiated transistors. The results show that a large part of the radiation damage annealed (gradual return of beta and leakage current to pre-irradiated values) but that a small part did not anneal (change in switching time). No indication was obtained yet of any radiation effect on the mean time to failure. (D.L.C.)

31052 SYMPOSIUM ON RADIATION EFFECTS ON METALS AND NEUTRON DOSIMETRY. Presented at the Fourth Pacific Area National Meeting, Los Angeles, Calif., October 2 and 3, 1962. ASTM Special Technical Publication No. 341. (American Society for Testing and Materials, Philadelphia). 415p. $15.00.

A review of the evolution of radiation effects theory and the development of analytical methods for studies of atomic interactions is presented. Experimental work paralleling theoretical analyses is described, and the complexities involved in the extrapolation of radiation effects models to complex alloy systems are illustrated. Neutron dosimetry is discussed. The foil-activation approach is outlined and radiation sensing devices and analytical techniques for neutron flux determinations are evaluated. Engineering studies on steels and other structural alloys are discussed. Separate abstracts are prepared for 16 of the 32 papers presented. Six papers were previously abstracted in NSA (16: 30907, 17: 3541, 6735, 14900, 16745, and 18852). (C.E.S.)

31053 STRUCTURE OF DISPLACEMENT CASCADES PRODUCED BY NEUTRON IRRADIATION. V. A. J. van Lint (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.33-45 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

Experiments were performed to measure the range-energy relation for recoiling atoms in solids. Recoiling atoms with energies between 10 and 500 kev were produced as a result of photonuclear reactions, such as (γ,n), (γ,p), and (γ,α). In addition to receiving kinetic energy by recoiling from the particle emission, the atoms are transmuted and thus can be detected by radiochemical techniques. These experiments indicated roughly an $E^{0.7}$ relation for the range and have shown that the average scattering angle for the particles is small enough that they retain most of the memory of their initial direction of motion. Analytical studies were also conducted, based on an exponentially screened Coulomb potential between two atoms. Scattering cross-sections were calculated by numerical means, and a Monte Carlo computer program was used for following the history of slowing-down atoms in a solid, for mass ratios between moving and target atoms both equal to unity and appreciably different from unity. The experimental data are in agreement with calculations based on the best available interatomic-potential functions. (auth)

31054 EFFECTS OF NEUTRON IRRADIATION ON PRECIPITATION-HARDENING ALLOYS. C. R. Cupp (International Nickel Co., Inc., Bayonne, N. J.). p.67-85 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

The effects of neutron irradiation on age-hardening alloys are of great importance in determining the usefulness of these alloys in reactors and are, in addition, of fundamental interest in determining the basic mechanisms of radiation effects. Most of the work was on alloys irradiated as supersaturated solid solutions, although some data are available for specimens irradiated in the aged condition. Irradiation can enhance solid state diffusion sufficiently to initiate precipitation or to allow growth of existing precipitates that can lead to overaging. In addition, precipitate nuclei can be redissolved by neutron irradiation. Either overaging or re-solution reduces the strength of the alloy and affects physical properties as well. The effects of irradiation on the mechanical, electrical, and magnetic properties of alloys are described and the effects, where possible, are related to structural changes. Copper–beryllium, nickel–beryllium, copper–iron, copper–cobalt, zirconium–niobium, certain nickel-base alloys, and precipitation-hardenable steels are studied. Work in progress includes studies of aluminum–copper and nickel–titanium alloys. (auth)

31055 FUNDAMENTAL ASPECTS OF RADIATION EFFECTS ON DIFFUSION-CONTROLLED REACTIONS IN ALLOYS. Monroe S. Wechsler (Oak Ridge National Lab., Tenn.). p.86-114 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

The vacancy mechanism of diffusion in metals and alloys is discussed and a review is given of the experimental evidence that supports it. The freezing-in problem and the theory of radiation-enhanced diffusion are treated from the point of view of the vacancy mechanism. Also, the ideas underlying the displacement production rate and the rate of vacancy annihilation are outlined. Finally, the results of theory are compared with experimental observations, particularly in regard to the temperature- and flux-dependence of radiation-enhanced diffusion. (auth)

31056 FAST-NEUTRON DOSIMETRY AT THE MTR-ETR SITE. C. H. Hogg and L. D. Weber (Phillips Petroleum Co., Idaho Falls, Idaho). p.133-40 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

Fast-neutron dosimetry at the Materials Testing Reactor–Engineering Test Reactor (MTR-ETR) Site consists of routine fast-flux measurement and the development of new techniques. The threshold reaction, $Ni^{58}(n,p)Co^{58}$, is being used where the high thermal-neutron cross-sections of the cobalt-58 isomers are not a detriment and the reactions $Ti^{46}(n,p)Sc^{46}$ and $Fe^{54}(n,p)Mn^{54}$ are used as alternatives. In the development program, 14 fast-neutron cross-sections averaged over the fission spectrum in Experimental Breeder Reactor I were measured relative to the assumed 0.57-mb value for the reaction $Al^{27}(n,\alpha)Na^{24}$. The reactions investigated and the fast-neutron cross sections in mb are: $Mg^{24}(n,p)Na^{24}$, 1.1; $Ti^{46}(n,p)Sc^{46}$, 9.0; $Ti^{47}(n,p)Sc^{47}$, 15; $Ti^{48}(n,p)Sc^{48}$, 0.25; $Mn^{55}(n,2n)Mn^{54}$, 0.18; $Fe^{54}(n,p)Mn^{54}$, 65; $Fe^{56}(n,p)Mn^{56}$, 0.71; $Ni^{58}(n,p)Co^{58}$, 90; $Ni^{60}(n,p)Co^{60}$, <0.5; $Cu^{63}(n,\alpha)Co^{60}$, 0.42; $Zn^{64}(n,p)Cu^{64}$, 25; $Zn^{66}(n,2n)Zn^{65}$, <4; $Mo^{92}(n,p)Nb^{92}$, 6.0; $Mo^{98}(n,p)Nb^{95}$, <0.1. (auth)

31057 FAST NEUTRON DOSIMETRY FOR LONG-TERM IRRADIATIONS. R. L. Ritzman, R. Lieberman, J. F. Kircher, and D. N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). p.141-50 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

Fission neutron cross sections were presented for (n,p) reactions with Ni^{58}, Fe^{54}, and Cu^{63} at threshold. The properties of these metals were studied for use as fast neutron threshold detectors in nuclear reactors. The Fe^{54} isotope was the most reliable since it has a well-established cross section, the Mn^{54} half life of 300 days allows irradiations of nearly one year, and Fe^{54} appeared to be unaffected by high thermal neutron fluxes. The Ni^{58} and Cu^{63} isotopes were subject to limitations when exposed to a high thermal neutron flux. (C.E.S.)

31058 THE USE OF SEMICONDUCTOR LITHIUM DRIFTED p-i-n JUNCTION DETECTORS FOR DOSIMETRY. Norman A. Baily and Gordon Kramer (Hughes Research Labs., Malibu, Calif.). p.151-61 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

Applications of the lithium drifted p-i-n junction semiconductor radiation detector in dosimetry are explored. Data on wavelength dependence for electromagnetic radiation, gamma-ray spectroscopy, and absolute sensitivity are given. The use of the device as the active component for a Bragg-Gray dosimeter is discussed. The application of the device to the measurement of charged particle spectra is discussed and typical experimental determinations are presented. The use of the detector for neutron dosimetry is discussed and the fundamental interactions for both thermal and fast neutrons are presented. Data on the stability of the active volume and the influence of storage conditions are presented. (auth)

31059 BRITTLE FRACTURE AND IRRADIATION EFFECTS IN FERRITIC PRESSURE VESSEL STEELS. R. W. Nichols (United Kingdom Atomic Energy Authority, Culcheth, Eng.) and D. R. Harries. p.162-98 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

Data on the brittle fracture characteristics of steel plates and methods for prevention of brittle fractures in reactor pressure vessels are presented. The results of experiments carried out to determine the effects of neutron irradiation and metallurgical variables on radiation damage and to investigate the mechanism of radiation hardening and embrittlement in ferritic steels are described. (C.E.S.)

31060 EFFECTS OF RADIATION ON TWO LOW-ALLOY STEELS AT ELEVATED TEMPERATURES. A. L. Lowe, Jr. (Babcock and Wilcox Co., Lynchburg, Va.). p.199-211 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

The effects of temperature during irradiation on the tensile and impact properties of two low-alloy steels were studied. Tension and impact specimens of 1.25 Cr-0.5 Mo and 2.25 Cr-1 Mo steels were irradiated in a range of 2.8×10^{19} to 2.0×10^{20} nvt and over a temperature range from room temperature to 1700°F. Results from postirradiation examinations conducted at room temperature indicate that the radiation effects on tensile properties are reduced at irradiation temperatures above 725°F and at irradiation temperatures between 900 and 1100°F there is no apparent irradiation damage. For specimens irradiated above approximately 1100°F the tensile and yield strength increased again and strength levels equal to the unirradiated values were not observed until the steel was heated above the A_3 point (1630°F). The second increase in tensile and yield strength may be associated with microstructural changes. Results

from subsize impact specimens showed that irradiated data equivalent to the unirradiated impact values were not recovered until temperatures in the stress relief range were reached. At the higher temperatures the shift in impact properties appears to be more sensitive to temperature than to radiation dose. (auth)

31061 EFFECT OF NEUTRON IRRADIATION AT 550 F ON CHARPY IMPACT PROPERTIES OF ASTM A 302 GRADE B STEEL. F. A. Brandt (General Electric Co., San Jose, Calif.) and A. J. Alexander. p.212-32 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

Test data are presented from the first three sets of a series of V-notch Charpy impact specimens irradiated with neutrons to measure the mechanical property changes of the pressure vessel steel. A number of groups of impact specimens were machined from the actual reactor pressure vessel steel, ASTM Specification A 302 grade B plate. They were placed, in sealed capsules, in the interior of the reactor pressure vessel where they were exposed to intense neutron irradiation at 545°F, the operating temperature of the reactor. Impact transition curves were determined on four groups of specimens covering a range of neutron exposure from 0 to 10^{19} nvt > 1 Mev. Based on the 30 ft-lb transition, the maximum increase in transition temperature measured was 150°F. Additional impact specimens are being irradiated in the reactor and will be removed periodically and tested over a 30-yr period. (auth)

31062 SURVEILLANCE TESTS ON STRUCTURAL MATERIALS IN NUCLEAR REACTORS. E. Landerman (Westinghouse Electric Corp., Pittsburgh). p.233-52 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

The standardization of surveillance tests on structural materials in nuclear reactors was made possible by ASTM recommended practices E 184 and E 185. The AEC survey of the surveillance programs in United States is presented. The use of four reference steels as correlation monitors was reviewed for existing surveillance programs. The distribution of correlation monitors is listed and indicates a need for wider application for radiation testing. The Yankee Atomic Electric Co. surveillance program for the reactor vessel is described, including preirradiation testing of material, type of specimens, location of specimens, use of neutron detectors and correlation monitors, post-irradiation tests, and schedule of program. (auth)

31063 IRRADIATION EMBRITTLEMENT AND HARDENING OF STEELS AND ZIRCALOY-2 IN PRESSURIZED COMPONENTS. E. Cibois, J. Lemaire, and Michel Weisz (CEN, Saclay, France). p.253-75 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

In the course of research on materials for pressurized components for gas-cooled reactors, a fundamental study was begun upon two kinds of materials: (1) manganese–molybdenum weldable steel similar to that used in the pressure vessels of the French gas-cooled graphite reactor projects, and (2) Zircaloy-2, chosen for the pressurized tubes of the French gas-cooled heavy water projects. Preliminary results are reported. Both impact tests and tension tests were performed in order to correlate brittleness and hardening after irradiation. Other tests were also made to study the recovery of steel following irradiation damage. Irradiation temperatures were 180°C for steel and less than 100°C for Zircaloy-2. In addition to tests on the original material, cold-worked materials and several heat treatments were studied in order to obtain different grain sizes and microstructures, with resulting increase in yield strength and change in transition temperature. Some attempts were made to correlate results with radiation damage theory. Conclusions agree well with those reported in the literature. (auth)

31064 EFFECTS OF NEUTRON SPECTRUM AND DOSE RATE ON RADIATION HARDENING AND EMBRITTLEMENT IN STEELS. D. R. Harries, P. J. Barton, and S. B. Wright (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.276-93 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963. (AERE-R-4222)

The Kinchin and Pease model for calculating the number of displaced atoms resulting from a fast neutron collision is described briefly and is used to calculate damage rates for iron irradiated in various calculated reactor neutron spectra. It is shown that the results of tension tests on stee specimens irradiated at 150°C in some reactor spectra can be used to determine the importance of energy loss by electronic excitation. The resulting damage function is used to predict the embrittlement of the CALDER HALL reactor pressure vessel steel from the results of accelerated irradiation tests. Preliminary results of investigations of the influence of neutron dose rate show no significant effect on the radiation hardening of mild steel at irradiation temperatures in the range 100 to 350°C. The method whereby the number of displaced atoms produced by thermal (n,γ) reactions can be calculated is described and the importance of this mode of damage relative to that produced by fast neutron scattering evaluated. It is shown that the embrittlement of the CALDER HALL pressure vessel steel is overestimated when both thermal (n,γ) and fast neutron displacements are considered. (auth)

31065 A STUDY OF NEUTRON IRRADIATION IN ALPHA IRON AND A 1Cr–0.5Mo PRESSURE VESSEL STEEL. B. L. Eyre (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.294-304 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

The preliminary results of an investigation of the effects of neutron irradiation on the deformation characteristics and structure of alpha iron and a 1 Cr–0.5 Mo pressure vessel steel are described. Neutron irradiation damage in alpha iron is similar to that produced in face-centered cubic metals with the exception that the interaction of dislocations with the defect clusters is dose-dependent in alpha iron. Irradiation of a 1 Cr–0.5 Mo steel at 250°C produces a redistribution of the precipitates in the matrix and an increase in the irregularity of the dislocation lines. (C.E.S.)

31066 RADIATION EFFECTS IN REACTOR STRUCTURAL MATERIALS. Myron B. Reynolds (General Electric Co., Pleasanton, Calif.). p.311-24 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

The effect of fast neutron radiation on the impact strength of two precipitation hardening stainless steels was determined using full-size Charpy V-notch specimens. The

brittle-ductile impact transition temperature of type 17-4 PH stainless steel aged at 1100°F was found to increase from approximately room temperature to values above 300°F after irradiation at 545°F to exposures in excess of 5×10^{19} neutrons per sq cm >1 Mev. The impact strength of doubly aged austenitic type A-286 stainless steel was found to increase from about 30 ft-lb in the unirradiated condition to approximately 50 ft-lb after irradiation. A technique for performing in-reactor slow-cycle fixed range fatigue tests on thin-walled tubing is described. Results of preliminary work on type 304 stainless steel tubing are presented. Irradiation in a core position during tests was found to produce a threefold decrease in strain cycle life of type 304 stainless steel in a configuration similar to that of fuel element cladding. (auth)

31067 RADIATION-INDUCED PROPERTY CHANGES IN AISI TYPE 347 STAINLESS STEEL. F. R. Shober and W. E. Murr (Battelle Memorial Inst., Columbus, Ohio). p.325-43 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

The changes in the mechanical properties of AISI type 347 stainless steel produced by irradiation at ~120°F to 4.7×10^{21} and 1.2×10^{22} neutrons per sq cm were determined by tension, impact, and hardness tests. The ultimate strength was increased from 90,000 to 114,000 psi, yield strength was increased from 38,000 to 104,000 psi, and elongation was reduced from 64 to 30 per cent at 75°F. Somewhat smaller changes were obtained at 600°F test temperature. A 1-hr anneal at 1800°F removed all effects of irradiation produced by 1.2×10^{22} neutrons per sq cm and reduced tensile properties at 75°F to essentially the same values as the unirradiated 347 stainless steel. Increased hardness of 347 steel resulting from irradiation was not removed by annealing at 600°F. The energy absorbed at fracture on irradiated Charpy V-notch specimens was 65 ft-lb at 75°F and 20 ft-lb at −300°F. Sufficient ductility in combination with the increased yield strength would appear to be more than adequate to warrant the service of this material in reactor environments of approximately 120°F to neutron exposures of 1.2×10^{22} neutrons per sq cm. (auth)

31068 EFFECT OF NEUTRON BOMBARDMENT ON STRESS-RUPTURE PROPERTIES OF SOME STRUCTURAL ALLOYS. Norman E. Hinkle (Oak Ridge National Lab., Tenn.). p.344-62 of "Symposium on Radiation Effects on Metals and Neutron Dosimetry." Philadelphia, American Society for Testing and Materials, 1963.

Stress-rupture experiments are conducted to study the effect of neutron bombardment on the rupture strength and deformation characteristics of stressed tubular specimens at controlled elevated temperatures in oxidizing or inert gas environments. The materials investigated are Inconel alloy 600, type 304 stainless steel, Zircaloy-2, and a niobium−1 per cent zirconium alloy. The rupture strength of Inconel alloy 600 at 1500°F is decreased as much as 25 per cent during irradiation. Smaller losses of rupture strength are observed for type 304 stainless steel at 1300 to 1500°F and the columbium alloy at 1800°F. No major change is observed for Zircaloy-2 at 700 or 900°F. The deformation-at-rupture of the Inconel and stainless steel alloys is generally lowered and metallographic evidence indicates that these premature ruptures occur because of lowered grain boundary cohesion. (auth)

31069 IMPROVEMENTS IN OR RELATING TO THE TREATMENT OF CELLULOSIC MATERIAL. (to Heberlein and Co., AG). British Patent 925,465. May 8, 1963. Priority date Apr. 29, 1960, Switzerland.

A process for improving a cellulosic material by irradiating the material with accelerated electrons is patented. The process can be applied to woven, knitted, or nonwoven fabrics composed wholly or partly of natural cellulose, such as cotton, or regenerated cellulose and to yarns or threads. The electrons should have a particle energy less than 1 Mev, and the material should be irradiated to a total dose of from 10^4 to 10^6 rad. The material is heated during or after irradiation to effect cross linking of the cellulosic material. Treated textiles show an increased resistance to creasing, abrasion, and shrinking. (M.P.G.)

31070 STABILIZING PIEZOELECTRIC CERAMICS. (to Clevite Corp.). British Patent 927,392. May 29, 1963. Priority date Aug. 31, 1959, United States.

Piezoelectric ceramics consist of polycrystalline aggregates of ferroelectric crystals that have been fired to ceramic maturity and subjected to electrostatic fields, giving them electromechanical properties similar to piezoelectric materials. The electromechanical properties of such ceramics can be improved, and the degradation with age of these properties lessened, by cyclically heating and quenching the materials and subsequently exposing them to gamma radiation doses of 10^4 to 10^9 roentgens. Results obtained with lead zirconate titanate are displayed. (D.C.W.)

PHYSICS

General and Miscellaneous

Refer also to abstracts 30819 and 30821.

31071 (AERE-R-4339) THE 1S-2S EXCITATION OF HYDROGEN ATOMS BY ELECTRON IMPACT, CALCULATED WITH THE USE OF THE SECOND BORN APPROXIMATION INCLUSIVE OF EXCHANGE. J. H. Tait and A. J. Taylor (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1963. 13p.

The second Born approximation with the inclusion of exchange is used for the calculation of the 1S-2S excitation cross section of hydrogen by electron impact to terms of the third order in the interaction energy. The intermediate states 1S, 2S, $2P_{0,\pm1}$, 3S are taken into account. The cross sections found are compared with experimental values and with results obtained by other theoretical methods. (auth)

31072 (AFOSR-4662) A GENERAL THEORY FOR THE FLOW OF WEAKLY IONIZED GASES. Report 644. S. H. Lam (Princeton Univ., N. J.). Apr. 1963. 49p.

A general theory is developed for the flow of a weakly ionized gas about arbitrary solid body or bodies with absorbing surfaces. The main interest lies in the prediction of the electrical response on the body surface as a function of the pertinent properties of the flow. The theory is based on continuum formulation, and is valid when the mean-free-path of the charged particles is at most the order of a Debye length and when the Debye length is much smaller than the thickness of the boundary layer adjacent to the body surface. The entire range of flow velocity in terms of an electric Reynolds number R is investigated, but the detailed analysis is devoted to the case $R^{-1/2} \ll 1$. It is found that the electrical disturbances can be divided distinctly into three physically distinct but mathematically uncoupled regions, namely the outer region, the ambi-polar diffusion region, and the sheath region. Closed-form analytical results are obtained for the floating potential and the current-voltage characteristic. These are useful in the interpretations of Langmuir probe data. Detailed structures of the solutions are given in terms of explicit universal functions. (auth)

31073 (ANL-6719) PHYSICS DIVISION SUMMARY REPORT, MARCH–MAY 1963. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 60p.

The levels in As^{73}, populated by the decay of Se^{73}, were studied. States at 0.425 and 0.066 Mev were found to decay by means of two cascade gamma rays with energies of 0.359 and 0.066 Mev, with no observed crossover transition. Half-lives of 5.0 ± 0.4 μsec and 6.1 ± 0.4 nsec were measured for the 0.425- and 0.066-Mev states, respectively. The 0.066-Mev transition, previously assigned as M1, was found to be retarded by a factor of 97 compared to single-particle estimates. This result tends to confirm the l-forbidden character of this transition. This retardation is compared with that for the 0.068-Mev transition in Ni^{61} that proceeds between analogous states. A program was initiated to investigate low-lying excited states which are populated by slow-neutron capture and subsequent γ-ray decay. The object of this series of investigations is to determine, where feasible, the lifetimes of these levels, and to obtain as much additional information as possible about these levels and the transitions proceeding from them. An outline and description of the experimental methods are presented. The gamma radiation following the capture of protons by B^{11} was extensively studied in the energy region $E_p = 4 - 10$ Mev, the region of the giant resonance in C^{12}. The work is part of a program to systematically study the capture of protons into the giant resonance. A search for particle-stable tetra neutrons and di neutrons in fission revealed that they occur with a frequency of less than 5×10^{-9} per fission. The neutron capture cross section for deuterium was measured relative to hydrogen by observing the relative intensities of the gamma rays emitted by the two nuclei. The capture cross section for deuterium is found to be 362 ± 26 μb. The existence of preferred ejection directions in the back sputtering of particles from a Cu(100) plane under deuteron bombardment was established for the Rutherford collision region. The data are compared with recently developed theories of cascades of focused collision sequences in the lattices of metal monocrystals. The s-wave and p-wave amplitudes for low-energy pion-pion scattering were calculated from the Mandelstam representation for the scattering amplitude. They agree closely with those of Chew, Mandelstam, and Noyes. The reflection coefficients for the various orders of reflection were calculated for a plane acoustic wave reflected from a two-dimensional, sinusoidal surface on which the pressure vanishes. The general trend of the experimental results agrees with experiment. A dynamical model for baryon-pseudoscalar meson scattering in the $P_{\frac{3}{2}}$ partial wave was analyzed in the framework of the Gell-Mann-Ne'eman octet model. Only one unknown parameter enters the calculation, and that parameter is restricted to a narrow range by comparison with experiment. A list of publications is included. (auth)

31074 (ANL-6744) MANY-PARTICLE THEORY OF INTERACTING PHONONS IN A CRYSTAL. J. J. J. Kokkedee (Argonne National Lab., Ill.). June 1963. Contract W-31-109-eng-38. 75p.

Many-particle perturbation theory and diagram techniques are used to examine the effects of phonon-phonon interactions in an ideal insulating crystal. The perturbation theory and diagram techniques are introduced, and are used to obtain expressions for the free energy of an anharmonic crystal, correlation functions, thermal averages, the one-phonon Green function, and phonon lifetime and self-energy. Lattice thermal conductivity and the coherent scattering of thermal neutrons by nuclei in a perfect, single crystal are also treated. (D.C.W.)

31075 (CONF-20-4) POSITRON ANNIHILATION IN RARE EARTH METALS. A. R. Mackintosh and D. R. Gustafson (Ames Lab., Ames, Iowa). [1962]. Contract [AT(11-1)-107]. 6p.

From 3rd Rare Earth Conference, Clearwater, Fla., April 1963.

The electronic structure of a number of rare earth metals was studied by measuring the angular correlation of the photons emitted when positrons annihilate with the electrons in the metal. From the results, it is deduced that gadolinium and cerium at room temperature each has approximately three conduction electrons per atom while ytterbium has approximately two, as expected from the localized f-electron model. Some qualitative information about the distortion of the Fermi surface and the polarization of the conduction electrons in the magnetically ordered state of gadolinium is also obtained. (auth)

31076 (CONF-46-40) ENERGETIC ATOM TUNNELING IN B.C.C.-F.C.C. METALS. D. G. Besco and J. R. Beeler, Jr. (General Electric Co. Advanced Technology Services, Cincinnati). May 1, 1963. Contract [AT(40-1)-2847]. 12p. (TM-63-5-3)

From American Physical Society Meeting, April 1963.

The study of energetic atom tunneling along preferred lattice directions and the possible effect of tunneling on radiation damage was extended to b.c.c. and f.c.c. metals. The calculations were performed using an IBM 7090 computer program designed to trace knock-on cascades and calculate point defect configurations in these structures. A modified Bohr potential was assumed, together with a threshold energy for displacement that is dependent upon ejection angle and surrounding damage pattern. Calculations were made for Kr bombarding Al and W targets, and for Cu and Fe atoms moving in their own lattices. Trajectories were simulated along directions (100), (110), and intermediate directions. In b.c.c., (100) was the most prominent tunneling direction, with a minimum stopping power 39% that of (110). In f.c.c., (110) was the most prominent tunneling direction, with a minimum stopping power 62% that of (100). Stopping powers for perfectly tunneled atoms were in the range 0.4 – 2.5 eV/Å. The number of defects created in cascades initiated by tunneling atoms was less than 10% that for normal trajectories, and the damage was confined to a region close to the tunnel trajectory. (auth)

31077 (CU(PNPL)-228) PEGRAM NUCLEAR PHYSICS LABORATORIES. Progress Report, October–December 1962. W. W. Havens, Jr. (Columbia Univ., New York. Pegram Nuclear Physics Labs.). Contract AT(30-1)-Gen-72. 46p.

Efforts devoted to decreasing the background as a factor in analysis of Nevis neutron velocity data are reported. Results on 20 elements investigated show that transmission measurements should be taken with several sample thicknesses to obtain unambiguous values for all parameters. Design and fabrication of a system to check solid-state detectors used in determining mass distribution of fission fragments by simultaneous energy and time-of-flight measurements are reported along with fabrication of a new target for producing neutrons by the $D(d,n)He^3$ reaction. Studies of low-frequency motions in polyethylene, polypropylene, and paraffin hydrocarbons by inelastic neutron scattering are reported. The total neutron cross section of $Mn-Zn-Fe_2O_4$ was measured at 78 to 507°K. A preliminary optical model analysis of proton scattering by Mg^{25} in the reaction $Mg^{26}(p,p)Mg^{26}$ is reported. Studies were initiated to show the feasibility of a search for the double beta decay of Ca^{48}. Data on two-photon de-excitation in Zr^{90} were obtained, and a preliminary data analysis is included. Results of a search for the two-proton level in Hf^{176} are reported. In instrument development, preparation of Li-drifted solid-state detectors is reported along with test results on hybrid charge-sensitive preamplifiers and design of a transistorized linear amplifier. Design of a stable transistorized 1 μsec pulse generator is also described along with design and use of a stable time-to-pulse-height converter and an auxiliary veto control for pulse-height analyzers. Design information on a dual-delay module is included along with modification information concerning the firing delay-control for Nevis Cyclotron. Other work on components for automation and instrument construction is discussed. (J.R.D.)

31078 (HW-77311) PHYSICS RESEARCH QUARTERLY REPORT, JANUARY–MARCH 1963. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 15, 1963. Contract AT(45-1)-1350. 55p.

Research on the scattering law for water, analysis of criticality limits, systematic errors in neutron total cross sections, and criticality in spheres containing plutonium nitrate solutions is reported. The section on neutron total cross sections was previously abstracted in NSA; abstracts for the other three sections were prepared. (D.C.W.)

31079 (HW-77311(p.4-11)) SCATTERING LAW FOR WATER. [PART] I. C. E. Lindenmeier (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The scattering law for water was calculated with the inclusion of finite widths of the resonance levels (Nelkin assumed infinitely sharp resonances) in the Egelstaff-type theory. Improved agreement was obtained between experiment and theory, particularly when a weighting of rotational to vibrational levels of about 0.4 was used. Relaxation of the condition that the vibrational levels be equally weighted is indicated. (D.C.W.)

31080 (HW-77311(p.12-18)) CRITICAL METRIC TENSOR. B. H. Duane (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The machine analysis of multi-energy transport theory was extended to provide achievement of criticality by variation of the metric tensor. The analysis was programmed for the IBM-7090 Electronic Data Processing System. An output deformation eigenvalue shows the shape and size deformation necessary to achieve criticality. The GE-HAPO Program S-XI, of which the analysis is a part, constructs multi-energy neutron and photon transport fields with plane, cylindrical, or spherical symmetry. (D.C.W.)

31081 (HW-77311(p.40-7)) CRITICAL EXPERIMENTS WITH PLUTONIUM NITRATE SOLUTIONS. R. C. Lloyd, E. D. Clayton, C. R. Richey, and S. R. Bierman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Critical experiments were conducted with plutonium nitrate solutions in an 11.5-inch diameter stainless steel sphere. The measured volume of the 11.5-inch sphere was 12.95 liters; the vessel wall thickness was 0.049 inch. Criticality in the water reflected sphere was studied as a function of nitrate concentration. Plutonium concentrations were in the range of 51 to 431 g Pu/liter, with low acid molarity (less than 2 in most cases). The data obtained yield a curve of critical concentration versus nitrate, which may then be used to estimate the critical concentration for a homogenous plutonium water mixture in the absence of nitrate, or to evaluate the minimum mass of plutonium in the sphere. Experiments were also conducted to determine the effect of the stainless steel vessel wall on the criticality of the water reflected unit. Pulsed neutron source experiments were conducted concurrently with critical mass measurements. Based on the measured neutron lifetimes and the prompt decay rates observed at various solution levels in the 11.5-inch sphere, effective multiplication constants were determined as a function of the plutonium concentration and solution volume in the sphere. One of the purposes of the pulsed neutron source experiments is to examine the feasibility of using this technique for k_{eff} measurements on in-plant equipment. Multigroup diffusion theory calculations were used to compute criticality for some of the solutions as used in the experiments, with a comparison between theory and experiment being given in terms of k_{eff}. (auth)

31082 (JINR-P-1264) MIKROSKOPICHESKOE OBOSNOVANIE RELYATIVISTSKOI GIDRODINAMIKI. (Microscopic Concept of Relativistic Hydrodynamics). N. A. Chernikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 27p.

Relativistic hydrodynamic equations for dissipative processes are derived from the relativistic kinetic equation obtained previously. The problem is solved by the method of moments. In order to extend the method of moments to the relativistic case, a relativistic generalization of the Hermite-Chebyshev polynomials is introduced. The viscosity and superconductivity coefficients are expressed in terms of definite integrals of the differential cross section for the gas particle interaction. The calculation fits well in both the non-relativistic and ultra-relativistic limiting transitions. (auth)

31083 (LA-2827) MONTE CARLO CALCULATIONS OF THE EQUATION OF STATE OF SYSTEMS OF 12 AND 48 HARD CIRCLES. W. W. Wood (Los Alamos Scientific Lab., N. Mex.). Sept. 1962. Contract W-7405-eng-36. 310p.

Monte Carlo calculations of the equation of state of two systems of hard circles (two-dimensional hard spheres), one consisting of 12 molecules and the other of 48 are presented. Periodic boundary conditions are used in both cases. The two-dimensional systems were considered in order to reduce "surface" effects for a given number of molecules, compared to three-dimensional systems, and in order to ascertain if certain phenomena appearing in previous calculations for three-dimensional systems (possibly indicative of the existence of a solid-fluid phase transition) would appear in the simpler two-dimensional systems. No such phenomena were found for the 12-molecule system. Except for certain trivial regions of configuration space, the Markov chains seemed to estimate adequately the over-all petit canonical ensemble pressure throughout the entire density range. The calculated pressure was a monotonically decreasing function of the area, and agreed approximately with the free-volume pressure at high densities, and with the virial expansion at low densities, when account was taken of the theoretical N-dependence at both extremes. The 48-molecule system gave qualitatively different results, except at the high and low density extremes where the behavior was as described for the smaller system. In the mid-density region the Markov chains were unable to estimate the ensemble average owing to a severe compartmentalization of configuration space into two crystallographically distinct types of configurations. The first, or L, type is related to the familiar regular hexagonal configurations. In the second, or H, type, two sub-classes could be distinguished. One consisted of irregular configurations, with a stochastic behavior more or less like that expected for a fluid. The other sub-class of H-type configurations was derived from a defect-lattice of 49 molecules in the rectangular cell, one molecule being replaced by a hole. Within the latter configurations, diffusion occurred over a considerable range of densities by the hole-diffusion mechanism. At reduced areas τ in the interval 1.3 to 1.35 ($\tau = 1$ in the close-packed regular hexagonal configuration), the system only infrequently changed back and forth between configurations of L and H type; transitions between the two H sub-types were rather frequent. At $\tau < 1.3$, L-H transitions were not observed. However, the system could be stabilized in H-type configurations of the defect type by means of "compression" from $\tau > 1.3$, the apparent pressure then considerably exceeding that of L-type configurations at the same reduced area. At $\tau > 1.4$ the L configurations and the defect type of H configurations progressively disappeared, as would be expected. It was concluded that while these phenomena, which are similar to those observed for three-dimensional hard spheres, may perhaps be the finite-system manifestation of the existence of a first-order phase transition in macroscopic systems, the calculations certainly do not establish that such is the case. An extensive statistical analysis is presented for the data reduction procedures required by the petit canonical ensemble Monte Carlo method, in which the equation of state must be obtained by numerically differentiating the directly estimable "cumulative pair-distribution function." It was concluded that use of Markov chains convergent to isothermal-isobaric ensemble averages might be advantageous. This was found to be feasible in some unpublished calculations for three-dimensional hard spheres. (auth)

31084 (NP-12966) SPATIALLY DEPENDENT ENERGY DISTRIBUTIONS FOR ELECTRONS DRIFTING THROUGH A GAS IN A UNIFORM ELECTRIC FIELD. Technical Report 18. James H. Parker, Jr. (Westinghouse Electric Corp. Research Labs., Pittsburgh). [1962]. Project DEFENDER. Contract NONR-2584(00). 52p.

The steady state distribution function is obtained for electrons initially emitted from a point source into a neutral gas and which subsequently drift under the influence of a uniform dc electric field while undergoing elastic collisions with the gas atoms. The distribution function is given as a sum of energy modes, each of which decay with distance from the source. The lowest of these modes is the far-distant distribution, while the higher ones, which decrease more rapidly with distance, describe the decay of the initial source energy distribution. The complete distribution is obtained in terms of known functions in the case of an energy independent collision frequency, whereas in the energy independent cross section case, only the lowest mode is obtained. The far-distant part of the distribution function is compared with the usual approximate expression that is obtained when the gradient terms are considered small and which is expressed as the density times a normalized energy function. It is shown, that when the gradient terms are correctly considered, the far-distant distribution in energy becomes position dependent. Furthermore, the deviation from the approximate theory becomes larger, the further the electrons are off the geometrical axis. This position dependence is most important when the electron energy is large in comparison to thermal energies. The interpretation of Townsend method for the determination of the ratio of the diffusion coefficient to the mobility, D/μ, is re-examined on the basis of this more exact theory. It is shown that the error in D/μ that results from using the conventional interpretation of this method under typical experimental conditions is never more than about 20%. (auth)

31085 (NP-12970) SECOND QUARTERLY REPORT FOR ADDITIVE CONVERTER STUDIES. A. L. Hyland (Thermo Electron Engineering Corp., Waltham, Mass.). 1963. Contract AF33(657)-10130. 23p.

An account of the cesium characteristics of the experimental thermionic converter is given, and the correlation to other rhenium emitter diodes is discussed. The experimental apparatus and the testing procedures are described. The program is designed to study the effect of additions of cesium compounds of electronegative elements such as fluorine, chlorine, and oxygen to the test chamber on the converter performance. (N.W.R.)

31086 (NP-12988) HIGH TEMPERATURE THERMOELECTRIC RESEARCH. Quarterly Progress Report No. 6,

March 29, 1963–June 28, 1963. C. M. Henderson (Monsanto Research Corp. Dayton Labs., Ohio). Contract AF33(657)-7387. 83p.

The experimental model generator, previously operated for 2556 hr at 1200°C in a vacuum of 10^{-5} to 10^{-6} mm Hg without degradation of power output, was disassembled and examined. No physical change or damage to its MCC 50-graphite thermoelements was found. Formulations of new p- and n-type thermoelectric materials, to supplement MCC 50, were standardized and techniques developed for forming them into segmented thermoelements. Realistic measurements of segmented p- and n-type thermoelements showed that efficiencies ranging from 3% for p-type to 6% for n-type can be attained for such units when operating between 1200 and 460°C. Emittance measurements on a new coating for use on the copper radiators of the advanced experimental model generator, or the surface of space vehicles, showed that it is capable of ϵ's ranging from 0.9 at 500°C to 0.98 at 900°C. Progress in overcoming hot-pressing problems and flame-spraying techniques concerned with making segmented thermoelements is described and a detailed design for an advanced experimental model generator capable of a nominal 50 watts output at ~10 watt/lb ratio is presented. (auth)

31087 (NP-12992) KRYPTON FILLED THERMIONIC CONVERTER. Quarterly Technical Progress Report No. 2, April 1, 1963–June 30, 1963. R. Forman (Union Carbide Corp. Parma Research Lab., Ohio). July 1963. Contract AF33(657)-10131. 23p.

Research work on irradiated inert gas thermionic diodes is presented. Tubes containing both argon and krypton gases were tested in the radiation field of a 5-Mw swimming pool type reactor. The pressure of the gas was varied in order to determine optimum conditions for operation. The results of these measurements are described and evaluated. Differences were observed on irradiated diodes having the same gas and pressure but different cathode-anode spacings. The differences, in contradistinction to cesium diodes, show that small cathode-anode spacing is not particularly advantageous. A proof in principle experiment is also described showing how an inert gas filled irradiated thermionic diode can be used as an a-c thermionic generator. (auth)

31088 (NYO-10462) ECONOMIC FACTORS OF MFP THERMOELECTRIC GENERATORS. Final Report. E. J. Lemanski (General Instrument Corp. Thermoelectric Div., Newark, N. J.). May 1963. Contract AT(30-1)-2605. 40p.

Economic aspects of power generation from underwater thermoelectric generators fueled with Mixed Fission Products (MFP) are given. Costs are estimated to be less than $0.15 per thermal watt for two year old MFP. Studies are on a conceptual design of a unit capable of withstanding pressures equivalent to 18,000 feet submergence on the ocean bottom and 300 year containment of the nuclear heat source. Low cost biological shields of both high density concrete and cast iron were considered. Studies establish the possibility of power costs as low as $10 per watt-year in the kilowatt size, to $100 per watt-year in the 10 watt range. A comparison of the MFP generator with an equivalent SNAP-7 strontium-90 type indicates that the MFP power costs are far below those for separated radioisotope power, primarily because the highest cost item in the SNAP unit is the purified strontium-90 fuel. A one kilowatt MFP unit would weigh in the order of 20 to 30 tons maximum depending on fuel energy density, and have a diameter of 6 to 10 feet. Optimization studies were made for such factors as fuel geometry, fuel age, energy density, and insulation thickness to determine the most productive areas of reducing the original cost and overall weight estimates. (auth)

31089 (PNE-104F) CLOSE-IN SHOCK STUDIES. Final Report. David B. Lombard and Dean V. Power (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 22, 1962. Contract W-7405-eng-48. 23p.

Measurements of shock parameters, including particle velocity profile and peak shock pressure, were attempted in the salt close-in to the Gnome nuclear explosion. The measurements were to be compared with results predicted by the UNEC code. Radiation-fogged film and damaged instruments nullified most of the measurements, but the experience gained will be valuable in designing instruments and techniques for similar experiments in the future. (auth)

31090 (SCTM-71-57(14)) DETERMINATION OF Q FACTORS AND OPERATING CHARACTERISTICS FOR MICROWAVE CAVITIES AND OSCILLATORS. W. P. Stearns (Sandia Corp., Albuquerque, N. Mex.). Apr. 12, 1957. Contract [AT(29-1)-789]. 76p.

A method for determining the Q factors of resonant microwave cavities is presented that has particular application to low, loaded cavities. By use of these Q factors it is shown how certain characteristics of the cavity, such as the circuit efficiency and pulling figure, may be determined. The method used for finding Q factors is based upon that presented in a series of papers by David J. Rose and Sanborn C. Brown. The theory and method for determining a Rieke diagram for a microwave oscillator is discussed in order to present a better understanding of the operation of microwave oscillators. (auth)

31091 (UCRL-10862) PHYSICS DIVISION SEMI-ANNUAL REPORT, NOVEMBER 1962 THROUGH APRIL 1963. (California. Univ., Berkeley. Lawrence Radiation Lab.). May 20, 1963. Contract W-7405-eng-48. 82p.

Progress in strange-particle research, bubble chamber operation and development, accelerator development and theory, data processing, computer programming, plasma physics, atomic and nuclear physics, scattering theory, meson studies (capture, decay, interactions, production), hyperon properties and production, nuclear reactions, cosmic proton research, particle physics, and spark chamber development is reported. (D.C.W.)

31092 (UCRL-Trans-923(L)) EQUATION OF STATE OF GASES AND CRITICAL STATE. Taro Kihara. Translated for Univ. of California Lawrence Radiation Lab., Livermore from Nippon Sugaku Butsuri Gakkaishi, 17: No. 2, 11-15(1943) as reprinted in J. Fac. Sci., Imp. Univ. Tokyo, 2: No. 5, 1943. 12p.

In connection with the virial expansion of the equation of state of gases, the third virial coefficient was integrated using a simple model for the intermolecular potential. The calculated values using constants derived from the second virial coefficient agreed very well with experimental values. Furthermore, quantities related to the critical state were calculated using an approximate equation that included up to the third virial coefficient; and it was shown that such an approximate equation could be of practical use. A similar consideration was also extended to two dimensional cases. (auth)

31093 THE SCATTERING AND POLARIZATION OF ELECTRONS BY HARTREE AND THOMAS-FERMI ATOMS. T. Tietz (Univ. of Lodz, Poland). Acta Phys. Acad. Sci. Hung., 16: 7-12(1963). (In English)

Using the analytical fits for the effective nuclear charge and the theory of scattering of a beam of particles by a center of force in the relativistic case, the asymmetry in

double scattering is discussed. The theory is presented in such a simple manner that the asymmetry in double scattering can be calculated without any difficulty in an analytical way. A generalization of the paper of Mohr and Tassie is given. (auth)

31094 TREATMENT OF THE H_2^+-ION BY MEANS OF ONE-, TWO- AND THREE-CENTER WAVE FUNCTIONS. I. Tamássy-Lentei and Á. Bába (Kossuth Lajos Univ., Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 16: 13-20(1963). (In English)

The ground state energy of H_2^+ is calculated with one and multi-center wave functions by means of the variational method. By using hydrogen-like one-center wave functions a bound state is found even with 1s function if it is centered near one of the nuclei. Results can be improved by taking the linear combination of two or three of the one-center wave functions of the type 1s, 2s, $2p_z$, $3d_z$. By varying the position of the center the best results are obtained when the center is either located in one of the nuclei or in the middle point between the nuclei. A better approximation can be obtained with the two-center linear combination of 1s type wave functions centered on the two nuclei. The results can be essentially improved with the three-center wave function that is a linear combination of 1s wave functions centered on the two nuclei and on the middle point. In this case the energy and the internuclear distance are $E = -0.5972\ e^2/a_0$ and $R = 2a_0$, respectively, corresponding to the exact values $-0.60263\ e^2/a_0$ and $2\ a_0$. (auth)

31095 THE HYDRODYNAMICAL MODEL OF WAVE MECHANICS. I. THE MOTION OF A SINGLE PARTICLE IN A POTENTIAL FIELD. L. Jánossy and M. Ziegler (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 16: 37-48(1963). (In English)

The problem is investigated as to how far the wave equation representing a quantum-mechanical system can be transformed by change of variables into a system of equations that have the form of the classical equation of motion of a deformable medium. This investigation is presented for the case of a single charged particle moving under the influence of an outside potential. (auth)

31096 GENERALIZED TETRAD FORMULATION OF GENERAL RELATIVITY THEORY (G.R.T.). A. E. Levashev and O. S. Ivanitskaya (Belorussian State Univ., Minsk). Acta Phys. Polon., 23: 647-53(Mar. 1963). (In English)

A method to overcome the difficulties connected with the world nongalileian coordinates in Einstein's General Relativity Theory (GRT) is presented. A formulation of the GRT that retains non-euclidian space-time geometry and the principle of general covariance, but at the same time operates with the field of orthonormal tetrads that are independent of the world nongalileian coordinates, is considered. Generalized transformations of the orthonormal tetrads with parallel displacement in space-time geometry from point to point are used. These transformations lead to the generalization of the connection of the tangent Minkowski spaces. (C.E.S.)

31097 THE ORIENTABILITY OF THE PHYSICAL TETRAD IN RELATIVISTIC ELECTRODYNAMICS. A. E. Levashev and V. I. Vorontsov (Belorussian State Univ., Minsk). Acta Phys. Polon., 23: 655-6(Mar. 1963). (In English)

The specific physical conditions that define the orientation properties of the physical tetrad in relativistic electrodynamics are investigated. Maxwell's equations that are covariant under dual transformations are utilized. (C.E.S.)

31098 EXPANDING FLOW IONIZATION NONEQUILIBRIUM: ITS CONTRIBUTION TO MHD GENERATORS. Harry Levin and Adolph R. Asam (Marquardt Corp., Van Nuys, Calif.). AIAA (Am. Inst. Aeron. Astronaut.). J., 1: 1715-16(July 1963).

Significant performance gain for MHD generators can result from the nonequilibrium behavior of a cesium ion seeding material in expanding flow. A particular application of the nonequilibrium behavior is reported for MHD generators to determine whether the nonequilibrium conductivity can be large enough to require inclusion in generator power calculations. It is found that in regimes of flow applicable to MHD generators contribution of nonequilibrium ionization can be neglected. (C.E.S.)

31099 MEASUREMENT OF THE SPECIFIC ACTIVITY OF A SOLUTION OF Au^{198}. F. Verdaguer and F. Sagastibelza (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 59: 28-33(Jan.-Feb. 1963). (In Spanish)

An absolute measurement of the specific β activity of a Au^{198} solution is presented. Two methods were used, the $4\pi\beta$ proportional counter and the $\beta-\gamma$ coincidence method. The results are compared with the corresponding mean values of the international ones on the same solution. (auth)

31100 ANGULAR DISTRIBUTION AND POLARIZATION OF K SHELL PHOTOELECTRONS IN THE HIGH ENERGY LIMIT. Bengt Nagel (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 24: 151-9(1963). (In English)

Expressions, involving the hypergeometric Appell function F_1 and exact in the high energy limit, are derived for the K shell photoelectric matrix elements. Suitable series expansions of the F_1 function, containing the angle variable in a simple way, are used for the numerical calculations, which are carried through for $\alpha Z = 0.3$, 0.6, and 1. (auth)

31101 A PROCEDURE FOR SMOOTHING GAMMA SPECTRA. P. Koeppe (Freien Universität, Berlin). Atompraxis, 9: 235-6(June 1963). (In German)

A perforated tape device is described for use in a procedure for smoothing the γ spectra obtained with multichannel analyzers and limited measurement time from weak radioactive preparations. The procedure is similar to that employed in compensation calculations. (C.H.)

31102 THE PROPAGATION OF NON-LINEAR ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. Hugo F. Kremer (Universidade, Parana, Brazil). Bol. Univ. Parana, Fis. Teorica, No. 4, 10p.(Nov. 1962). (In Spanish)

The propagation of an electromagnetic perturbation is studied within the framework of general relativity by a theory of the Born-Infield type with a general lagrangian $\mathcal{L} = \sqrt{-g}\ L$. L is any function of the single invariants furnished by the tensor electromagnetic field $f_{\alpha\beta}$. Possible discontinuities of the first derivatives of the electromagnetic field on crossing a hypersurface of ν_4 (the field of electromagnetic phenomena) are examined by the method of Levi-Civita. The equation of the hypersurfaces of discontinuity is established, and a physical interpretation is presented. (tr-auth)

31103 THEORY OF MASS SPECTRA. G. R. Lester (Imperial Chemical Industries Ltd., Blackley, Manchester, Eng.). Brit. J. Appl. Phys., 14: 414-21(July 1963).

The most probable distributions of electrons and vibrational energy quanta, specifically their relation to observed fragmentation patterns, are discussed. The main features of the quasi-equilibrium theory are outlined in a form as

close as possible to the conventional statistical mechanical treatment of ordinary chemical kinetics. Pursuing this correspondence, the significance that might be assigned to temperature as a defined variable in mass spectral processes is considered. Applications of the theory to some typical organic compounds are described, and computational procedures for the evaluation of frequency factors are explained. The possibility of using mass spectrometry to supplement conventional organic chemistry in, for example, the study of organic catalysts is also considered. (auth)

31104 INTRINSIC CHARACTERISTIC EQUATIONS FOR RELATIVISTIC COMPRESSIBLE HYDROMAGNETIC FLOWS. N. Coburn (Univ. of Michigan, Ann Arbor). Bul. Inst. Politeh. Iasi, (N.S.), 7(XI): 61-82(1961). (In English)

Intrinsic forms of basic equations for the conservation of mass and stress-energy, entropy along a streamline, and the Maxwell equation independent of the unknown current are derived for a relativistic compressible hydromagnetic fluid of infinite conductivity. Then the density, worldline, and relativistic magnetic vectors are determined for two classes of solutions of the equations: in a flow of special relativity and in a Newtonian flow. Both cases correspond to flows with infinite characteristic hypersurfaces that are parallel hyperplanes in special relativity. (auth)

31105 THE THICKNESS OF MOVING HELIUM II FILM. P. W. F. Gribbon and L. C. Jackson (Royal Military Coll., Kingston, Ont.). Can. J. Phys., 41: 1047-55(July 1963).

The thickness of moving liquid helium II films is measured using the polarized-light method. The moving film is that on the outside of a cylindrical stainless steel beaker emptying by creep at the rate corresponding to the temperature, at 1.68 and 1.83°K. Measured at a height of 1 cm above the outer level of the liquid the thicknesses are 5.6% and 4.5% less than those of the stationary film at 1.68 and 1.83°K respectively. The observations are compared with the theoretical expressions for the difference in thickness of stationary and moving films. (auth)

31106 KINETIC EQUATION DESCRIBING IRREVERSIBLE PROCESSES IN IONIZED GASES. [PART] II. R. L. Rosenberg and Ta-you Wu (National Research Council, Ottawa). Can. J. Phys., 41: 1193-1225(July 1963). (NRC-7484)

The theory of irreversible processes is considered in a spatially inhomogeneous plasma. The kinetic equation, in terms of $g(\kappa,n,t)$, the Fourier transform of the spatially inhomogeneous part $f(r,n,t)$ of the one-particle distribution function $F(r,n,t)$, is obtained to first order in $4\pi e^2$, all orders in $(4\pi e^2/v)$, and first order in κ, which is related to the spatial inhomogeneity. The kinetic equation is given in which are exhibited: the stream term; the corrections to the stream term arising from the "collisions"; the Vlasov term; the corrections, in the zeroth and first order in κ, to the Vlasov term depending not only on the "static" effective field but also on the divergence of the mean current, these corrections being momentum-dependent and time-irreversible in nature; and the main "collision integral" which is time-irreversible, in the zeroth and the first order in κ. (auth)

31107 MAGNETIC MEASUREMENTS ON XeF_4. S. Maričić (Inst. "Ruder Bošković," Zagreb); Z. Veksli, J. Slivnik, and B. Volavšek. Croat. Chem. Acta, 35: 77-80 (1963). (In English)

It is found that XeF_4 is diamagnetic from 77 to 293°K. Fluorine chemical shift anisotropy is established by n.m.r. measurements at 29 Mc/s. It changes sharply at 250°K from 5.7 ± 0.2 to $1.4_7 \pm 0.1$ gauss, indicating restricted molecular motion. The pure nuclear dipole-dipole second moment at low temperatures appears to be in agreement with the value calculated from the crystal structure data of XeF_4. (auth)

31108 THE LOWER CRITICAL FIELD IN THE GINZBURG-LANDAU THEORY OF SUPERCONDUCTIVITY. J. L. Harden and V. Arp (National Bureau of Standards, Boulder, Colo.). Cryogenics, 3: 105-8(June 1963).

An evaluation was made of H_{c2}, the lower critical field or the maximum field in which the sample can be completely superconducting. Abrikosov's calculations of H_{c2}/H_{cb} were repeated using a high-speed computer, and the results are plotted along with Abrikosov's results. The results were also applied to recent work on Pb–Tl alloys, and the calculated K's agree well with these calculated from H_{c1}/H_{cb}. (D.L.C.)

31109 MAGNETIC SUSCEPTIBILITY OF DIATOMIC MOLECULES. M. Karplus and H. J. Kolker (Columbia Univ., New York). J. Chem. Phys., 38: 1263-75(Mar. 15, 1963).

A variation–perturbation method is presented for the calculation of the magnetic susceptibility tensor χ from a single-determinant ground-state wavefunction for a $^1\Sigma$ molecule. The diamagnetic contribution χ^d is obtained directly by first-order perturbation theory and the paramagnetic contribution χ^p is determined by extremizing a functional corresponding to the second-order energy in an external magnetic field. By an appropriate choice of perturbation function and zero-order Hamiltonian, the functional is expressed in a relatively simple form requiring only one-electron matrix elements. The importance of employing Hartree–Fock functions as the zero-order solution is stressed and an analysis given of the order of the errors in the variation–perturbation treatment. Calculations are made of the magnetic susceptibility tensor for a series of diatomic molecules. Ransil's minimal basis set functions serve as unperturbed wavefunctions and a four-term polynomial is used to represent orbital perturbations in the second-order treatment. The values obtained for χ^d, χ^p, and χ of H_2, Li_2, N_2, F_2, LiH, HF, LiF, and CO are presented. Comparisons with the available magnetic data for the molecules demonstrate that the variation–perturbation method is a useful tool for ab initio susceptibility calculations. For the more difficult paramagnetic term χ^p, criteria for the convergence of the second-order energy are discussed and applied to the molecules considered. The magnetic anisotropy ($\Delta\chi = \chi_\perp - \chi_\parallel$) is evaluated theoretically for hydrogen and found to be in reasonable agreement with experiment. The inaccuracies arising in $\Delta\chi$ values for more complex species (through differencing in a purely theoretical treatment) are overcome by the inclusion of rotational magnetic moment data to obtain relatively reliable results. To examine the effect of the vibrational state on the susceptibility of a molecule, exploratory calculation is made for LiH, which demonstrates that small but significant deviations from the equilibrium-distance value are to be expected. (P.C.H.)

31110 INFLUENCE OF VIBRATION-ROTATION INTERACTION ON THE TRUE VIBRATIONAL WAVEFUNCTIONS. D. C. Jain (Saha Inst. of Nuclear Physics, Calcutta). J. Chem. Phys., 38: 1300-3(Mar. 15, 1963).

A method is suggested for obtaining the true vibrational wavefunctions corrected for vibration–rotation interaction by the application of perturbation theory. For this purpose the harmonic oscillator wavefunctions were considered to

be perturbed by the potential $V' = [U(r) - V_0(r)] + [\hbar^2 J(J + 1)/2\mu r^2]$, where U(r) is the true potential, $V_0(r)$ is the harmonic oscillator potential, and $[\hbar^2 J(J + 1)/2\mu r^2]$, the vibration–rotation interaction term. Expressions are given for the integrals $\int \bar{\psi} v' J' \psi v'' J'' dr$ and $\int \bar{\psi} v' J' \xi \psi v'' J'' dr$, which occur in the transition-moment matrix elements for electronic bands. Similar integrals occurring in the dipole-moment matrix elements for vibration–rotation bands can also be evaluated by using these wave functions. (auth)

31111 COLLISION LIFETIMES AND THE THERMODYNAMICS OF REAL GASES. Felix T. Smith (Stanford Research Inst., Menlo Park, Calif.). J. Chem. Phys., 38: 1304-10(Mar. 15, 1963).

By a simple intuitive argument, interactions during collisions of molecules in real gases can be taken into account exactly if the collision lifetimes are known. The product of collision rate and lifetime gives the concentration of transient collision complexes, which must be considered in the perfect gas law along with the stable species. As a result, the complete virial expansion is obtained, in both quantal and classical mechanics. The argument leads further to a new form for the partition function that includes the continuum as well as bound states. From this all the thermodynamic functions can be obtained. (P.C.H.)

31112 TRIPLET–TRIPLET ANNIHILATION AND DELAYED FLUORESCENCE IN MOLECULAR AGGREGATES. H. Sternlight, G. C. Nieman, and G. W. Robinson (California Inst. of Tech., Pasadena). J. Chem. Phys., 38: 1326-35 (Mar. 15, 1963).

Triplet–triplet annihilation in pure and mixed organic crystals is discussed. In crystals containing a small concentration of impurity traps, triplet excitation migration may proceed from trap to trap on a time scale that is short compared with the long triplet state lifetime but that is long compared with the normal fluorescence lifetime. Nearest-neighbor and long-range mutual annihilation of two triplets may then take place giving rise to delayed fluorescence. The rates of long-range triplet excitation migration and annihilation show a concentration dependence, temperature dependence, and solvent dependence. Provided the triplet–triplet annihilation rate is not too fast, the intensity of the delayed fluorescence can be shown to depend upon the square of the intensity of the exciting light. This expectation is borne out by experiments, briefly reported, on delayed fluorescence in dilute isotopic mixed crystals. In crystals containing high concentrations of such impurity traps, or in pure crystals, the annihilation rate becomes extremely rapid and the mechanism effectively quenches phosphorescence in many, but not all, classes of pure organic crystals. The kinetics of the over-all process are discussed in both the limits of fast and slow annihilation rates. A theoretical investigation of the origin of the annihilation matrix element was carried out, and it is shown that exchange interactions play the largest role in determining annihilation rates. (P.C.H.)

31113 MODIFIED SUM RULE FOR THE VIBRATIONAL FREQUENCIES OF SYMMETRICAL ISOTOPIC MOLECULES. Katsunosuke Machida (Kyoto Univ.). J. Chem. Phys., 38: 1360-7(Mar. 15, 1963).

A general method of applying the modified sum rule for the vibrational frequencies of symmetrical isotopic molecules was derived. The rule states that the difference in the sum of the frequency parameters between two isotopic molecules A and A*, $\Delta\sigma = \Sigma\lambda(A) - \Sigma\lambda(A^*)$, is the same for the appropriate sets I, II, ... of the symmetry species. The sets I, II, ... are selected in accordance with the interactions between the equivalent atoms involved in the isotopic change from A into A*. Various sum-rule relations are obtained for a given pair of isotopic molecules depending upon the interaction terms of the potential function. The proof of the rule is given by using the property of the transformation from the internal coordinates into the symmetry coordinates. Application of the rule is illustrated for ethylene, benzene, and their deuterated homologs. (auth)

31114 RADIATIVE LIFETIME OF I_2 FLUORESCENCE, $B\ ^3\Pi_{0_u}^+ \rightarrow X\ ^1\Sigma_{0_g}^+$. Leo Brewer, Robert A. Berg, and Gerd M. Rosenblatt (Univ. of California, Berkeley). J. Chem. Phys., 38: 1381-8(Mar. 15, 1963).

The radiative lifetime of the fluorescence of molecular iodine vapor, $B\ ^3\Pi_{0_u}^+(v' = 26) \rightarrow X\ ^1\Sigma_{0_g}^+$, was determined to be $(7.2 \pm 1.0) \times 10^{-7}$ sec by using a phase fluorometer. Measurements on equilibrium vapor were carried out over the pressure range 10^{-4} to 5 mm Hg. Results at the lowest pressures are considerably shorter than the true lifetime owing to mixing of scattered, incident light with the fluorescence. This effect was corrected analytically. At higher pressures the measured lifetime is shortened by self-quenching. A Stern-Volmer plot of the data yields a self-quenching collision diameter for I_2 of 11.3 Å. Measurements were also carried out with a molecular beam of iodine vapor. (auth)

31115 CORRELATION ENERGY AND THE ONE-CENTER COULOMB REPULSION INTEGRAL. Tadashi Arai and Peter Lykos (Argonne National Lab., Ill.). J. Chem. Phys., 38: 1447-8(Mar. 15, 1963).

A distinction is made between the various contributions to the difference between theoretical and empirical values of correlation energy associated with the two-pi-electron system. (P.C.H.)

31116 GASEOUS DIFFUSION IN POROUS MEDIA. III. THERMAL TRANSPIRATION. E. A. Mason (Univ. of Maryland, College Park), R. B. Evans, III, and G. M. Watson. J. Chem. Phys., 38: 1808-26(Apr. 15, 1963). (IMP-AEC-23)

A previously proposed model for the diffusion of gases in porous media at uniform and nonuniform pressures was extended to allow for temperature gradients. The porous medium is visualized as a collection of "dust" particles constrained to remain stationary in space. As before, by formally treating the "dust" particles as giant molecules, it is possible to cover the entire range of intermediate mechanisms from the Knudsen to the normal region by varying the mole fraction of the real gas. For binary systems (a single gas and "dust"), the phenomenon of thermal transpiration is accounted for by the model in a consistent way for all aspects which are diffusive in character but, as before, needs modification at high pressures by the addition of an expression to account for the viscous backflow. With this modification, an equation is obtained which describes thermal transpiration over the entire pressure range. This equation discloses two new relationships not previously noticed: one between the maximum in the thermal transpiration curve and the Knudsen minimum in the permeability curve, and one between the height of the thermal transpiration maximum and the translational heat conductivity of the gas. It was found that it was possible to extend the model to include capillaries as well as porous media. This extension disclosed that the relationships applicable to porous media would also describe the analogous behavior that occurs in capillaries with definite geometry. The capillary results reproduce previous semi-empirical and empirical equations of Weber and Liang for thermal transpiration, and the permeability equation of Knudsen. The present equations, however, have fewer adjustable

parameters than do the previous equations. A simple connection, not previously mentioned, between Weber's and Liang's equations was also noticed: Liang's equation is really a special form of Weber's equation written in a differential-approximation form. A remarkable feature of the results, as applied to capillary systems, is that one can calculate rotational relaxation times in gases from the height of the thermal transpiration maxima, which suggests much simpler experimental techniques than those previously employed for the measurement of this phenomenon. (auth)

31117 CALCULATION OF MEAN ATOMIC POSITIONS IN VIBRATING POLYATOMIC MOLECULES. L. S. Bartell (Iowa State Univ., Ames). J. Chem. Phys., 38: 1827-33 (Apr. 15, 1963).

A new method is described for calculating effects of anharmonic vibrations on bond lengths and angles in polyatomic molecules. It is shown that the quantum mechanical analog of Newton's second law of motion leads to simple equilibrium conditions from which it is possible to calculate mean displacements of atoms from positions of minimum potential energy. The method resembles the standard first-order perturbation method insofar as it relates mean displacements to mean-square displacements which can be computed from the zeroth-order harmonic problem. It gives a much more direct calculation, however, circumventing the laborious nonlinear transformations between internal and normal coordinates encountered in the perturbation method. Advantages and limitations are discussed. Applications to several problems are outlined briefly, including isotope effects and effects of temperature on mean molecular structures. The approach extended to crystal lattices, is shown to account for Grueneisen's relation which correlates thermal expansion and heat capacity. Numerical results of calculations are presented for H_2O, D_2O, NH_3, and ND_3, comparing the present method with other methods. Contrary to prevailing opinion, the mean apical angle of NH_3 appears to be smaller than that of ND_3. (auth)

31118 SLATER-CONDON PARAMETERS FROM SPECTRAL DATA. Juergen Hinze and H. H. Jaffe (Univ. of Cincinnati). J. Chem. Phys., 38: 1834-47(Apr. 15, 1963).

Slater-Condon parameters were fitted by least-squares methods, as far as spectroscopic data are available, for all the neutral atoms of the first three periods of the periodic system, and for their isoelectronic mono-positive ions, and for the isoelectronic di- and tri-positive ions of the first two periods. Separate evaluations were performed for each configuration, and for pooled data from all configurations. It is concluded that the approximations involved in the Slater-Condon method are at least as serious as the further approximations introduced by pooling of data from several configurations. (auth)

31119 INELASTIC ATOMIC SCATTERING. [PART II.] Jules W. Moskowitz and Walter R. Thorson (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 38: 1848-52(Apr. 15, 1963).

Cross sections for the transitions $^2P_{\frac{1}{2}} \rightleftharpoons {}^2P_{\frac{3}{2}}$ in an alkali atom in collision with a rare-gas atom were calculated for thermal impact energies by the use of a modified "distorted-wave" approximation. These calculations are part of a continuing comparison study on the effectiveness of several different approximations in predicting inter-multiplet transitions. Numerical results agree qualitatively with experiment but this agreement is fortuitous and is not the immediate aim of the calculation. The critical features of such calculations are briefly discussed. (auth)

31120 HYPERFINE INTERACTIONS IN SOLUTIONS OF Cs AND Rb IN METHYLAMINE. Kenneth D. Vos and James L. Dye (Michigan State Univ., East Lansing). J. Chem. Phys., 38: 2033-4(Apr. 15, 1963).

Of all the alkali metals studied in methylamine and ethylenediamine, only Rb and Cs in methylamine showed hyperfine splitting in their ESR spectra. Rb shows a six-line spectrum and Cs an eight-line spectrum. The splitting indicates an appreciable electron density at the metal nucleus. The electron densities of Cs and Rb^{87} in methylamine at 25°C are calculated to be 6.9 and 3.5%, respectively, of that for the free atoms. (D.L.C.)

31121 FLUORESCENCE IN MIXED CRYSTALS OF Ce: $PrCl_3$. Jack S. Margolis (North American Aviation Science Center, Los Angeles), Oscar Stafsudd, and Eugene Y. Wong). J. Chem. Phys., 38: 2045-6(Apr. 15, 1963).

The observations of Varsanyi and Dieke on the absorption of a single photon by two ions in the fluorescence of $PrCl_3$ were confirmed by experiments in which a simultaneous transition to $^1G_4$ and $^3P_0$ levels was found. In order to show that the collective absorption of photons is not due to the similarity of participating ions, experiments were also carried out on $CeCl_3$ doped with 1% Pr. Fluorescences at 22450, 23200, 23400-23600, and 24500 cm^{-1} were observed which fit in well with the assignment of the combinations $^3P_0 + {}^2F_{\frac{5}{2}}$, $^3P_1 + {}^2F_{\frac{5}{2}}$, $^1I_6 + {}^2F_{\frac{5}{2}}$, and $^3P_2 + {}^2F_{\frac{5}{2}}$, respectively. (D.L.C.)

31122 MOLECULAR ORBITAL STUDIES OF DIATOMIC MOLECULES. III. THE GROUND STATE OF THE HYDROGEN MOLECULE. Frank E. Harris and Howard S. Taylor (Univ. of California, Berkeley). J. Chem. Phys., 38: 2591-6(June 1, 1963).

A method of molecular orbital computation described previously was applied to the $X\ ^1\Sigma_g$ state of hydrogen. The potential curve is reported and the significance of the results is discussed. (auth)

31123 SEMICLASSICAL ANALYSIS OF THE EXTREMA IN THE VELOCITY DEPENDENCE OF TOTAL ELASTIC-SCATTERING CROSS SECTIONS: RELATION TO THE BOUND STATES. Richard B. Bernstein (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 38: 2599-2609(June 1, 1963). (TID-18168)

The phenomenon of extrema in the velocity dependence of the total elastic cross section $Q(v)$ for atom-atom scattering in the thermal-energy region is shown to be a quite general one, whenever the interaction potential consists of both attractive and repulsive parts and the resulting well has a capacity for one or more discrete levels. The phase shift vs angular-momentum dependence exhibits a maximum; since this maximum is a function of the de Broglie wavelength, the cross section exhibits an undulatory velocity dependence. A semiclassical analysis of the extrema velocities (and undulation amplitudes) is presented. Suitable plots are suggested from which certain information on the interatomic potential and the diatom bound states may be deduced. It is proposed that: the observation of m maxima in the elastic atom–atom impact spectrum implies the existence of at least m discrete vibrational levels of zero angular momentum for the diatom. (auth)

31124 THE SPECTRAL EMISSIVITY OF CATHODES COATED WITH STRONTIUM OXIDE. C. H. B. Mee (Univ.

of Southampton, Eng.). J. Electron. Control (1), 14: 629-31 (June 1963). (In English)

The spectral emissivity of O-nickel cathode tubes coated with Sr oxide 40 and 50 μ thick was measured. The emissivity was found to range from 0.185 to 0.235, with a mean value of ~0.20. (D.L.C.)

31125 CRYSTAL PHASES OF NICKEL AS RELATED TO ADHESION OF THERMIONIC COATINGS AND TO EMISSION PHENOMENA. Aurelius Sandor (Phylectron Lab., Montreal). J. Electron. Control (1), 15: 1-19(July 1963). (In English)

For conventional oxide cathodes, the possibility of forming microseparations between the nickel base and the coating during the activation phase is demonstrated in a large-screen thermionic emission microscope. When using work-hardened nickel, shearing forces necessarily occurring during recrystallization owing to crystal growth and grain-boundary expansion must lead to disruption of the base-to-coating contact. Severe limitations to emission current by increased resistance, next to interface resistance, are imminent. A preventive measure of pre-heating all cathode sleeves at 1200°C is recommended. Artificial activation of the polycrystalline nickel base by a thin-film barium layer leads to the qualitative observation of anomalous emission phenomena as caused by the anisotropy of different crystal planes. Emission reversal with decreasing temperature, crystal memory shapes, preferential etchability of higher work function planes, and recovery after apparent barium exhaustion and after hot oxygen poisoning are among the observations. Theoretical efforts for reconciling apparent contradictions seem essential since thin-film activation appears to be the ultimate mechanism of electron emission in any thermionic cathode structure. (auth)

31126 IONIZATION CROSS SECTIONS IN He, Ne, A, Kr, AND Xe BY ELECTRON IMPACT. R. K. Asundi and M. V. Kurepa (Univ. of Liverpool). J. Electron. Control (1), 15: 41-50(July 1963). (In English)

Measurements of the total ionization cross sections for the rare gases helium, neon, argon, krypton, and xenon under electron impact extending over the electron energy range up to 100 ev were made with a Tate and Smith apparatus and a Lozier-type apparatus. The two sets of measurements show close agreement with one another in the entire electron energy range; however, some deviation from earlier data is observed. The first ionization potentials were determined using an absolute method for the electron energy calibration, and the agreement with the spectroscopic values is within the error in the electron energy measurement, which is ±0.08 ev. (auth)

31127 EFFECTIVE ELECTRON RECOMBINATION IN HEATED NITROGEN. Michael H. Mentzoni (Sylvania Electronic Systems, Waltham, Mass.). J. Geophys. Res., 68: 4181-6(July 15, 1963).

Microwave diagnostic methods were used to measure the effective electron recombination rate α_r in the afterglow of a pulsed dc discharge as a function of gas temperature T and pressure p in the ranges 300 to 735°K and 0.5 to 6.0 mm Hg, respectively. It is found that α_r has a value of 1.2×10^{-7} cm^3 sec^{-1} at T = 300°K and p = 1.0 mm Hg, which is considerably smaller than most previously reported values. Over this temperature range α_r decreased with T, by roughly one order of magnitude at p = 2.0 mm Hg, and more than two orders of magnitude at p = 6.0 mm Hg, the sharpest decrease taking place above T = 600°K. The increase of α_r with pressure became smaller as the temperature was raised, ultimately leading to a decrease of α_r with pressure at T = 735°K. (auth)

31128 DIVERGENCE CONDITIONS AND THE GRAVITATIONAL FIELD EQUATIONS. Heinz R. Pagels (Stanford Univ., Calif.). J. Math. Phys. (N. Y.), 4: 731-4(June 1963).

It is shown that in addition to the four divergence laws $T^{\alpha\beta}{}_{|\beta} = 0$, stress tensors satisfying the Einstein field equations must also satisfy the additional divergence conditions $(T^{\alpha\,|\beta} - T^{\gamma\beta|\alpha})_{|\gamma} = 0$. Conversely, under quite general assumptions these ten conditions on the source, $T_{\alpha\beta}$, dictate the metric-matter connection proposed by Einstein. (auth)

31129 FERMI NORMAL COORDINATES AND SOME BASIC CONCEPTS IN DIFFERENTIAL GEOMETRY. F. K. Manasse and C. W. Misner (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 4: 735-45(June 1963).

Fermi coordinates, in which the metric is rectangular and has vanishing first derivatives at each point of a curve, are constructed in a particular way about a geodesic. This determines an expansion of the metric in powers of proper distance normal to the geodesic, of which the second-order terms are explicitly computed in terms of the curvature tensor at the corresponding point on the base geodesic. These terms determine the lowest-order effects of a gravitational field that can be measured locally by a freely falling observer. An example is provided in the Schwarzschild metric. This discussion of Fermi Normal Coordinate provides numerous examples of the use of the modern, coordinate-free concept of a vector and of computations that are simplified by introducing a vector instead of its components. The ideas of contravariant vector and Lie Bracket, as well as the equation of geodesic deviation, are reviewed before being applied. (auth)

31130 DISTORTION IN THE METRIC OF A SMALL CENTER OF GRAVITATIONAL ATTRACTION DUE TO ITS PROXIMITY TO A VERY LARGE MASS. F. K. Manasse (Princeton Univ., N. J. and Bell Telephone Labs., Holmdel, N. J.). J. Math. Phys. (N. Y.), 4: 746-61(June 1963).

The problem of two bodies in general relativity in an especially restricted mode is analyzed. One body is of small mass, and, under the influence of gravitational attraction, moves toward a much larger mass whose field produces tidal deformations in the geometry of the smaller one. To evaluate these deformations, the Schwarzschild metric of the particle is treated by a perturbation analysis similar to that performed by Regge and Wheeler. The boundary conditions for this analysis are obtained from the metric of the background field expressed in a novel set of comoving coordinates, here called Fermi normal coordinates. The Schwarzschild metric given in comoving coordinates is used as an asymptotic approximation for the full solution that is evaluated. A perturbation analysis using the tidal deformation as an expansion parameter is performed on the metric of a small Schwarzschild particle. The solution so obtained satisfies Einstein's equations for empty space for small deviations from a nonflat metric. This solution also reduces to the Fermi metric in the appropriate limit, namely, when the distance from the geodesic is large compared to the radius of the small mass but small compared to the separation of the two masses. Thus only the quadratic terms in the distance are important. This solution is then used to find the deformations in shape of the throat of the wormhole and to locate this region of symmetry by finding a coordinate transformation that leaves the metric invariant. (auth)

31131 PARAMETER DIFFERENTIATION OF QUANTUM-MECHANICAL LINEAR OPERATORS. Kôitsiro Aizu (Hitachi Central Research Lab., Tokyo). J. Math. Phys. (N. Y.), 4: 762-75(June 1963).

Quantum-mechanical linear operators have some real-number parameters in them. The differential coefficients of functions, including eigenvalues and eigenvectors, of such an operator with respect to a parameter are calculable from the differential coefficient of the operator with respect to the parameter. The formulas for this purpose are presented together with their proofs. (auth)

31132 GALILEI GROUP AND NONRELATIVISTIC QUANTUM MECHANICS. Jean-Marc Levy-Leblond (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Math. Phys. (N. Y.), 4: 776-88(June 1963).

The Galilei group and its representations are studied. The Galilei group presents a certain number of essential differences with respect to the Poincaré group. As Bargmann showed, its physical representations, explicitly constructed, are not true representations but only up-to-s-factor ones. Consequently, in nonrelativistic quantum mechanics, the mass has a very special role, and in fact, gives rise to a superselection rule that prevents the existence of unstable particles. The internal energy of a nonrelativistic system is known to be an arbitrary parameter; this is shown to come also from Galilean invariance, because of a nontrivial concept of equivalence between physical representations. On the contrary, the behavior of an elementary system with respect to rotations, is very similar to the relativistic case. It is shown in particular, how the number of polarization states reduces to two for the zero-mass case. Finally, the two-particle system, where the orbital angular momenta quite naturally introduce themselves through the decomposition of the tensor product of two physical representations, is studied. (auth)

31133 PRINCIPLE OF GENERAL Q COVARIANCE. D. Finkelstein (Yeshiva Univ., New York), J. M. Jauch, S. Schiminovich, and D. Speiser. J. Math. Phys. (N. Y.), 4: 788-96(June 1963).

The physical implications of quaternion quantum mechanics are explored. In a quaternionic Hilbert space $\mathfrak{H}_Q$, the lattice of subspaces has a symmetry group that is isomorphic to the group of all co-unitary transformations in $\mathfrak{H}_Q$. In contrast to the complex space $\mathfrak{H}_C$ (ordinary Hilbert space), this group is connected, while for $\mathfrak{H}_C$ it consists of two disconnected pieces. The subgroup of transformations in $\mathfrak{H}_Q$ that associates with every quaternion q of magnitude 1, the correspondence $\psi \rightarrow q\psi q^{-1}$ for all $\psi \in \mathfrak{H}_Q$ (called Q conjugations), is isomorphic to the three-dimensional rotation group. The principle of Q covariance is postulated: the physical laws are invariant under Q conjugations. The full significance of this postulate is brought to light in localizable systems where it can be generalized to the principle of general Q covariance: physical laws are invariant under general Q conjugations. Under the latter are understood conjugation transformations that vary continuously from point to point. The implementation of this principle forces one to construct a theory of parallel transport of quaternions. The notions of Q-covariant derivative and Q curvature are natural consequences thereof. There is a further new structure built into the quaternionic frame through the equations of motion. These equations single out a purely imaginary quaternion $\eta(x)$ that may be a continuous function of the space–time coordinates. It corresponds to the i in the Schrödinger equation of ordinary quantum mechanics. $\eta(x)$ is considered as a fundamental field, much like the tensor $g_{\mu\nu}$ in the general theory of relativity. A classical theory of this field is given by assuming the simplest invariant Lagrangian that can be constructed out of η and the covariant Q connection. It is shown that this theory describes three vector fields, two of them with mass and charge, and one massless and neutral. The latter is identifiable with the classical electromagnetic field. (auth)

31134 REDUCTION OF S-MATRIX ELEMENTS. A. Syed (Imperial Coll., London). J. Math. Phys. (N. Y.), 4: 797-808(June 1963).

Expressions for the commutators of in- and out-fields are obtained with the generalized retarded operators of Burgoyne and Ruelle. These are then used to show that the matrix element $(p_1, \cdots, p_m \text{ out}/-p_{m+1}, \cdots, -p_n \text{ in})$, where $p \equiv (p_1, p_2, \cdots, p_n)$ is arbitrary, can be reduced in terms of retarded functions without using the assumption of stability of one-particle states. (auth)

31135 LORENTZ-LORENZ AND SELLMEIER FORMULAS IN IRREGULAR GASES. Leonard S. Taylor (General Electric Space Sciences Lab., Valley Forge, Penna.). J. Math. Phys. (N. Y.), 4: 824-8(June 1963).

The integral equation expressing the condition of dynamical equilibrium of dipoles in an applied electromagnetic field is solved to determine the index of refraction for the ensemble-average wave in a media in which the polarizability varies irregularly. The solution closely follows that employed in the usual derivation of the Ewald–Oseen theorem for isotropic media. A Lorentz–Lorenz formula, modified by the appearance of an additional term, is determined. The additional term is real when the scale length of the irregularities is small compared to the wavelength. For larger irregularities, however, the correction leads to a complex index of refraction, expressing the attenuation due to scattering. Applying the concept of the depolarizing effect of electron-ion collisions, these results are extended to the case of an ionized gas. In this latter instance, a similar modification of the Sellmeier formula for the index of refraction is determined. Explicit formulas are given for the case of irregularities with scale large compared to a wavelength. (auth)

31136 CHARGED SPHEROID IN CYLINDER. W. R. Smythe (California Inst. of Tech., Pasadena). J. Math. Phys. (N. Y.), 4: 833-7(June 1963).

The problem of a charged conducting spheroid within a coaxial conducting cylinder is solved by a slight variation of a previous method. Errors in the terminal digits of Table I in the previous paper were corrected and the table extended. The charge density on the spheroid, the potential between it and the cylinder; and its capacitance are given for ratios of the spheroid equatorial radius to cylinder radius of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, and 0.95. Tables give numerical results for five cases: the disk, the oblate spheroid with 2 to 1 axial ratio, the sphere, and the prolate spheroid with axial ratio 1 to 2. The thin prolate spheroid requires special treatment. (auth)

31137 SINGULARITIES OF THE FOUR-POINT FUNCTION IN PERTURBATION THEORY WITH VARIABLE MASSES. Francis R. Halpern (Univ. of California, San Diego). J. Math. Phys. (N. Y.), 4: 879-84(July 1963).

The Landau surface for the four-point function with one or more variable external masses is parameterized. The real singularities of the four-point function with one external mass are explicitly determined. The locations of the complex singularities of the function depend on the choice of the cuts for the three-point function. Several suggestions are made as to how these could be taken. (auth)

31138 DENSITY MATRICES ARISING FROM INCOMPLETE MEASUREMENTS. Eyvind H. Wichmann (Univ. of California, Berkeley). J. Math. Phys. (N. Y.), 4: 884-96(July 1963).

The problem of how to associate a statistical ensemble of a quantum mechanical system with an incomplete set of measured ensemble averages is discussed. The view chosen is that the most chaotic ensemble consistent with the measured ensemble averages is a reasonable choice of ensemble. The properties of this ensemble are studied rigorously for the case when the quantum mechanical system is associated with a finite-dimensional Hilbert space. The results are extended heuristically to some particular ensembles of many-boson and many-fermion systems. (auth)

31139 N-DIMENSIONAL TOTAL ORBITAL ANGULAR-MOMENTUM OPERATOR. Kenneth D. Granzow (Sandia Corp., Albuquerque, N. Mex.). J. Math. Phys. (N. Y.), 4: 897-900(July 1963). (TID-17955; SCDC-3057)

A set of generalized polar coordinate systems is defined in N-dimensional space. The total orbital angular-momentum operator as defined by Louck is found to be a tensor invariant on the (N−1)-dimensional unit sphere; hence it is easily explicitly determined in any of the possible generalized polar coordinate systems. Commuting operators can be found and the eigenvalue problem solved in many coordinate systems. Two examples are given: a coordinate system of 3M dimensions where M is an integer, and a coordinate system of 8 dimensions. (auth)

31140 A REMARKABLE REPRESENTATION OF THE 3 + 2 DE SITTER GROUP. P. A. M. Dirac (Cambridge Univ., Eng. and Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.), 4: 901-9(July 1963).

Among the infinitesimal operators of the 3 + 2 de Sitter group, there are four independent cyclic ones, one of which is separate from the other three. A representation is obtained for which this one has integral eigenvalues while the other three have half-odd eigenvalues, or vice versa. The representation is of a specially simple kind, with the wavefunctions involving only two variables. (auth)

31141 EMPTY-SPACE GENERALIZATION OF THE SCHWARZSCHILD METRIC. E. Newman, L. Tamburino, and T. Unti (Univ. of Pittsburgh). J. Math. Phys. (N. Y.), 4: 915-23(July 1963).

A new class of empty-space metrics is obtained, one member of this class being a natural generalization of the Schwarzschild metric. This latter metric contains one arbitrary parameter in addition to the mass. The entire class is the set of metrics that are algebraically specialized (contain multiple-principle null vectors) such that the propagation vector is not proportional to a gradient. These metrics belong to the Petrov class type I degenerate. (auth)

31142 THE FLATTER REGIONS OF NEWMAN, UNTI, AND TAMBURINO'S GENERALIZED SCHWARZSCHILD SPACE. Charles W. Misner (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 4: 924-37(July 1963).

The "generalized Schwarzschild" metric discovered by Newman, Unti, and Tamburino, which is stationary and spherically symmetric, is investigated. The orbit of a point under the group of time translations is found to be a circle, rather than a line as in the Schwarzschild case. The time-like hypersurfaces r = const that are left invariant by the group of motions are topologically three-spheres S^3, in contrast to the topology $S^2 \times R$ (or $S^2 \times S^1$) for the r = const surfaces in the Schwarzschild case. In the Schwarzschild case, the interaction of a spacelike surface t = const and an r = const surface is a sphere S^2. If σ is any spacelike hypersurface in the generalized metric, then its (two-dimensional) intersection with an r = const surface is not any closed two-dimensional manifold, that is, the generalized metric admits no reasonable spacelike surfaces. Thus, even though all curvature invariants vanish as $r \to \infty$, in fact $R_{\mu\nu\alpha\beta} = O(1/r^3)$ as in the Schwarzschild case, this metric is not asymptotically flat in the sense that coordinates can be introduced for which $g_{\mu\nu} - \eta_{\mu\nu} = O(1/r)$. An apparent singularity in the metric at small values of r, which appears to be similar to the spurious Schwarzschild singularity at r = 2m, was not studied. (auth)

31143 INITIAL-VALUE PROBLEM ON EINSTEIN-ROSEN MANIFOLDS. Richard W. Lindquist (Adelphi Coll., Garden City, N. Y.). J. Math. Phys. (N. Y.), 4: 938-50 (July 1963).

A class of solutions of the time-symmetric initial-value equations for gravitation and electromagnetism is obtained on a two-sheeted manifold containing N Einstein-Rosen bridges. The initial metric tensor and electric field are expressed in terms of a pair of harmonic functions, called "metric potentials," which are required to be analytic and asymptotically flat and to satisfy certain match-up conditions; these potentials are then determined by applying the method of inversion images. The particular case of two identical Einstein-Rosen bridges is examined in detail, and is shown to correspond to a wormhole in an asymptotically flat (one-sheeted) universe. A charge and "renormalized mass" are defined for each Einstein-Rosen bridge, as well as an interaction energy (gravitational plus electrostatic potential energy) for the system as a whole. Expressions for these and other physical characteristics are evaluated explicitly in the two-body case. (auth)

31144 UNDULATORY RIEMANNIAN SPACES. C. Lanczos (Dublin Inst. for Advanced Studies). J. Math. Phys. (N. Y.), 4: 951-9(July 1963).

A demonstration is given that Riemannian spaces of very high curvature in submicroscopic domains do not contradict the existence of a macroscopic line element that is nearly Minkowskian. The signature of the microscopic line element is positive definite, and the wave property of the metric in macroscopic domains comes about by a peculiar "wave-guide action" of a strongly curved, two-dimensional line element, in harmony with the particle-like behavior of the photon. The four-dimensional lattice structure of the metrical vacuum field does not establish an absolute frame of reference and can be harmonized with the macroscopic validity of the Lorentz transformations. (auth)

31145 ON THE NUMBER OF SELF-AVOIDING WALKS. Harry Kesten (Cornell Univ., Ithaca, N. Y.). J. Math. Phys. (N. Y.), 4: 960-9(July 1963).

Let χ_n be the number of self-avoiding walks on the integral points in Euclidean d space and γ_n the number of n-stepped self-avoiding polygons. It is shown that $\chi_{n+2}/\chi_n - \beta^2$ and $\gamma_{2n+2}/\gamma_{2n+1} - \beta^2$ tend to zero as $n \to \infty$ where $\beta = \lim_{n\to\infty} \chi_n^{1/n}$. Asymptotic estimates for these differences are given. β is also characterized as the unique positive root of $\sum_1^\infty \lambda_k x^{-k} = 1$ where the λ_k are the number of certain k-stepped self-avoiding walks. (auth)

31146 NEW METHOD FOR SOLVING EIGENVALUE PROBLEMS. Tatuya Sasakawa (Univ. of California, Los Angeles). J. Math. Phys. (N. Y.), 4: 970-92(July 1963).

A new method of solving eigenvalue problems is proposed. The secular equation is represented in the form of a dispersion relation. Three methods of solving the dispersion

relation are given. Several examples including both non-degenerate cases and degenerate cases are presented. All these examples demonstrate that the present treatment is better than other conventional perturbation treatments. The transformation coefficients between the unperturbed wavefunctions and the perturbed ones are given in terms of the eigenvalues thus obtained. The wavefunctions of the perturbed states form a complete orthonormal set if those of the unperturbed one do. (auth)

31147 SOLUTION OF THE CAUCHY PROBLEM FOR LAPLACE'S EQUATION IN AXIALLY SYMMETRIC SYSTEMS. Kenneth J. Harker (Stanford Univ., Calif.). J. Math. Phys. (N. Y.), 4: 993-7(July 1963).

The determination of the electrodes for an electron gun reduces to solving the Cauchy problem for Laplace's equation. Using Green's Theorem, an analytic solution for the case of axial symmetry is obtained in terms of a line integral involving the product of the analytically continued values of the voltage and normal electric fields at the beam edge by an appropriate weighting function. Since an explicit solution is given in terms of line integrals, numerical results should be obtained far more accurately and quickly than those obtained by integrating Laplace's equation directly by finite-difference methods. (auth)

31148 DISPLACEMENT OF ENERGY LEVELS OF ATOMS BY LIGHT. Alfred Kastler (Ecole Normale Superieure, Paris). J. Opt. Soc. Am., 53: 902-10(Aug. 1963).

Recent results obtained by the development of optical-pumping techniques, and especially on the thesis of Cagnac and the thesis of Cohen-Tannoudji are summarized. Cagnac has used the optical-pumping technique to achieve nuclear orientation in the ground state of the odd mercury isotopes and has made an extensive study of the longitudinal relaxation time. Barrat and Cohen-Tannoudji have developed the quantum-mechanical theory of the optical-pumping cycle of an atom and Cohen-Tannoudji in his thesis has confirmed the theoretical predictions experimentally by applying Dehmelt's cross-beam technique to Hg^{199}. If a collection of atoms is irradiated permanently by light that can be absorbed and re-emitted, this pumping cycle has different effects on the ground-state properties of the atoms; these effects are experimentally detectable by observing the magnetic resonance of the atomic ground state. A broadening of the magnetic-resonance line proportional to the light intensity occurs. It is due to the shortening of the lifetime of the ground-state Zeeman levels by light absorptions. Other effects are displacements of the Zeeman levels of the ground state caused by irradiation resulting in a change of the magnetic-resonance frequency. Theory predicts displacements of 2 different kinds: Displacements caused by real transitions — during an up-and-down transition of an atom, coherence is partly conserved. As a result, a certain amount of the g factor of the excited state is mixed with the g factor of the ground state. Displacements caused by virtual transitions — these displacements are related to the dispersion of light. All these effects, predicted by the theory, were qualitatively and quantitatively confirmed by Cohen's experiments. (auth)

31149 HIGH-INTENSITY LIMIT OF THOMSON SCATTERING. P. Stehle (Space Technology Labs., Redondo Beach, Calif.). J. Opt. Soc. Am., 53: 1003(Aug. 1963).

The breakdown of quantum electrodynamics in the limit of high intensity rather than that of high energy is considered. High-intensity effects show up in those terms in the s matrix that depend on the quantization volume of the field. Such terms in Thomson scattering in which the lowest-order terms are volume independent are shown to lead to breakdown of the perturbation theory in which the photons are counted if the first and second order matrix elements are of the same order of magnitude. (auth)

31150 TWO CENTER COULOMB POTENTIAL APPROXIMATION. Mikio Shimizu (Tokyo Univ.). J. Phys. Soc. Japan, 18: 811-19(June 1963).

An expression in the prolate spheroidal coordinates is given for the wave function of a slow electron scattered by a pair of point charges, $Z_a e$ and $Z_b e$, fixed at a distance. The two-center Coulomb function is useful to approximate the wave function of a slow electron in the fields of diatomic molecular ions or polar molecules. By use of this approximation, the diffusion cross-section of electrons by polar molecules and the photoionization cross-section of hydrogen molecules near threshold energy are calculated. In these cases, the calculated cross-sections are about $1.3 \sim 2$ times smaller than the experimental ones. (auth)

31151 THE FORBIDDEN 222 ELECTRON REFLECTION FROM GERMANIUM. Mieko Takagi and Setsu Morimoto (Tokyo Inst. of Tech.). J. Phys. Soc. Japan, 18: 819-24(June 1963).

The strength of the forbidden 222 reflection in reflection electron diffraction patterns from a slightly etched (111) face of a germanium single crystal is shown to be independent of crystal orientation. It is thus due to 'systematic interaction' rather than 'accidental interaction.' The strength of the 222 ring from evaporated, polycrystalline germanium films was studied as a function of particle size in the range 70 to 300 Å and with accelerating voltage in the range 20 to 200 kv, and was compared with values calculated from Hoerni's theory and from Fujimoto's theory with Fujiwara's relativistic correction. At the larger values of λD, at which Fujimoto's expansion cannot be used, agreement between Hoerni's theory and experiment is satisfactory. At lower values of λD the calculated 222 intensity with relativistic correction is 50% higher than the experimental value. (auth)

31152 THERMIONIC ANALOGUE OF JOSHI EFFECT IN MAZE TYPE COUNTER IN ARGON. R. J. Galagali (Banaras Hindu Univ., India). J. Phys. Soc. Japan, 18: 825-30(June 1963).

Experiments are carried out to explain the occurrence of Joshi Effect in a "free electron" gas such as argon. The influence of increased thermionic emission on the discharge current is also studied. (auth)

31153 HODOGRAPH METHOD FOR TREATING THE FLOW OF A PERFECTLY CONDUCTING FLUID WITH ALIGNED MAGNETIC FIELD. Kinzo Hida (Osaka Univ. Prefecture). J. Phys. Soc. Japan, 18: 864-70(June 1963).

It is shown that the fundamental equations for two-dimensional steady flows of an inviscid, compressible, perfectly conducting gas with aligned magnetic field are reduced to the corresponding ones without magnetic field by making use of a suitable transformation. In the hodograph plane of these reduced variables, characteristics, a family of exact solutions, and shock relations are studied in a way similar to the case of ordinary hydrodynamics. Numerical calculations are made for the spiral flow. The shock polar equation is also obtained, with special reference to a few typical shock waves characteristic to magnetohydrodynamics. (auth)

31154 TETRAD FIELDS AND GRAVITATIONAL FIELDS. C. Pellegrini and J. Plebanski. Kgl. Danske

Videnskab. Selskab, Mat. Fys. Skrifter, 2: No. 4, 1-39 (1963). (In English)

The consequences of the hypothesis that gravitation may be described by a tetrad field, are examined by studying the most general Lagrangian obtained as a linear combination of invariants. A particular choice of these can be made on the basis of correspondence with the Newtonian theory. The field equations obtained from this particular Lagrangian, although somewhat different from those of Møller, give rise, in the case of a static, spherically symmetric system, to the usual Schwarzschild metric. Moreover, in the cases considered explicitly by Møller, the solutions of the field equations are the same. A conserved energy-momentum complex having the property that the energy density is localizable is also derived. The use of a tetrad field to describe the structure of space-time allows the introduction of spinor fields, and in particular of the neutrino field, in a natural way. A new coupling between fermions and gravitation also follows from this theory. (auth)

31155 ON A SPECIAL REPRESENTATION IN QUANTUM THEORY. Heinz Koppe. Kgl. Norske Videnskab. Selskabs, 35: No. 5, 25-32(1962). (In English)

The mathematical background behind a representation of canonically conjugate operators that is derived by passing over from the Schrödinger p,q operators to creation and destruction operators is discussed. (D.C.W.)

31156 MEASUREMENTS BY A HIGH-FREQUENCY ION SOURCE. János Nagy and Péter Gombos. Magy. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 5: 39-46 (May 1963). (In Hungarian)

Investigations were made on the production of He^{2+} ions by high-frequency ion sources. Magnetic analyses showed the relative abundance to be 2.4% including the contaminating H_2^+ ions. Measurements were carried out by means of a novel-type multi-bored extraction probe. A pre-focused H-ion current of 8 ma was obtained with 30 cm^3/hr gas consumption and 100 w oscillator output. Experiments were made concerning the image formation characteristics of cylinder-symmetrical pre-focusing lenses of electrostatic type in the case of ion beams of rectangular shape. The lens distorted the beam image to a large extent. An attempt was made to pulse-operate the developed high-frequency ion source. The ion current had a pulse duration of 5 to 500 μsec, a frequency of 50 to 5000 cps, 1 μsec rise time, and 2 μsec decay time. (auth)

31157 APPROXIMATION METHODS IN A SUPERCONDUCTING MODEL. H. Mitter and K. Yamazaki (Max-Planck-Institut für Physik und Astrophysik, Munich). Nucl. Phys., 44: 187-94(June 1963). (In English)

In the strong-coupling limit of the Bardeen-Cooper-Schrieffer-theory, the amplitudes of operator products are calculated. Various methods to define convergent sets of amplitudes are considered, and the convergence is studied for large but finite volume. For amplitudes between states of equal particle numbers, the usual new Tamm-Dancoff method (random phase approximation) gives the best results. For states of different particle numbers a modification of this method (which is an extension of Gorkov's approximation) is better by at least one order of magnitude. (auth)

31158 LINKED GRAPH EXPANSION FOR THE LOGARITHM OF THE NORM OF MANY-BODY WAVE FUNCTIONS. J. Da Providencia (Universidade de Coimbra, Portugal). Nucl. Phys: 44: 572-8(July 1963). (In English)

A general method is developed whereby the logarithm of the norm of many-body wave-functions is explicitly expressed in terms of cluster integrals. It is found that some concepts introduced by Lee and Yang in quantum statistics have a counterpart in the theory, leading to considerable simplifications. (auth)

31159 THE CLASSICAL CALCULATION OF THE PROBABILITIES OF EXCITATION AND IONIZATION OF ATOMS BY ELECTRON IMPACT. V. I. Ochkur and A. M. Petrun'kin. Opt. Spectry. (USSR) (English Transl.), 14: 245-8(Apr. 1963).

The problem of the excitation or ionization of an atom or molecule is examined on the basis of classical mechanics in the two-body approximation. Expressions are derived for the ionization cross section and the total excitation cross section for all levels lying in a given energy interval. In all cases, the calculated values agree with the experimental data in order of magnitude. They also agree with Darwin's empirical formula for ionization; therefore, this formula is recommended, with slight modifications, for calculating the excitation cross section also. (auth)

31160 CALCULATION OF THE EXCITATION OF IONS BY ELECTRONS USING COULOMBIC WAVE FUNCTIONS. M. K. Gailitis. Opt. Spectry. (USSR) (English Transl.), 14: 249-51(Apr. 1963).

Cases are discussed in which the excitation cross section of ions may be described by an analytical expression not requiring series expansion of the wave functions of the continuous spectrum with respect to moments. Cross sections are calculated for optically allowed transitions in the dipole approximation for any ions, and for S-S transitions in hydrogen-like ions. (auth)

31161 ENERGY LEVELS IN A DEBYE FIELD. V. L. Bonch-Bruevich and V. B. Glasko. Opt. Spectry. (USSR) (English Transl.), 14: 264-8(Apr. 1963).

The energy spectrum of a particle in a field with the potential $V(r) = -(q^2/r)\exp(-r/r_0)$ is obtained by a numerical method. The number and location of energy eigenvalues are found as functions of the characteristic parameter $g = 2r_0mr^2/\hbar^2$ (where m is the mass of the particle). The removal of the l degeneracy is studied, and an approximate estimate is given for the probability of a transition without a change in the principal quantum number and a unit change in l. (auth)

31162 FREE-FREE TRANSITIONS OF THE ELECTRON IN THE ION FIELD. G. E. Norman. Opt. Spectry. (USSR) (English Transl.), 14: 277-9(Apr. 1963).

A previously presented method for calculating the absorption coefficient, stipulated by the photoionization of excited many-electron atoms, is extended to free–free transitions of an electron in an ion field. The matrix element of the free–free transition of the electron in the ion field is obtained by extrapolation of the matrix elements of the bound–free transitions calculated by Burgess and Seaton. The extrapolation is correct according to exact expressions known for transitions of an electron in a proton field. The results show that the application of Kramers' formula to stopping processes in an ion field can give an error of several times: for ions of some elements values too large, for other elements values too small. The Unsöld correction can increase this discrepancy still more. (auth)

31163 SUPER RANGES OF FAST IONS IN COPPER SINGLE CRYSTALS. H. Lutz and R. Sizmann (Technische Hochschule, Munich). Phys. Letters, 5: 113-14(June 15, 1963). (In English)

Copper single crystals were bombarded with radioactive Kr^{85} ions at 10 to 150 kev. By removing thin layers of Cu

containing K^{45} and determining the radioactivity after each removal, the range distributions perpendicular to the crystal directions (110), (111), and (100) were obtained. The (110) distribution was quite different from the others and showed that Kr atoms were located up to 20 times deeper than the average range. Lattice atoms are believed to focus Kr particles in channels in the (100) and, particularly, the (110) directions. (D.C.W.)

31164 DERIVATION OF THE EQUATIONS OF RELATIVISTIC HYDRODYNAMICS FROM THE RELATIVISTIC TRANSPORT EQUATION. N. A. Chernikov (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 5: 115-17(June 15, 1963). (In English)

The relativistic hydrodynamic equations of dissipative processes occurring in a gas are derived from the relativistic kinetic equation using a generalization of the method of moments developed for the non-relativistic case. A dependence of the heat conductivity and viscosity coefficients on the differential cross section for the gas particle interaction and on the local gas temperature is noted. (D.C.W.)

31165 A SIMPLE APPROACH TO THE SCHWARZSCHILD SOLUTION. K.-E. Eriksson and S. Yngstroem (Univ. of Uppsala). Phys. Letters, 5: 119(June 15, 1963). (In English)

Schwarzschild's exterior solution of Einstein's field equations holds for a static spherically symmetric gravitational field outside the gravitating center. The solution is herein derived using the following postulate: the motion of a fixed point in S on the path of L is given in L by Newton's law of gravitation. L is an inertial system moving in S, a stationary spherically symmetric coordinate system, in a specific radial direction. (D.C.W.)

31166 ON THE UNCERTAINTY RELATION FOR L_z AND φ. D. Judge (University Coll., Dublin and Dublin Inst. for Advanced Studies). Phys. Letters, 5: 189(July 1, 1963). (In English)

The z-component of orbital angular momentum L_z can be represented in wave mechanics by the differential operator $-i\hbar\,\partial/\partial\phi$. L_z and ϕ are shown to obey an uncertainty relation of the form $\Delta L_z\ \Delta\varphi/[1-3(\Delta\varphi)^2/\pi^2] \geq 0.15\ \hbar$ rather than $\Delta L_z \Delta\varphi \geq \frac{1}{2}\hbar$. (D.C.W.)

31167 ON THE COMMUTATOR $[L_z,\varphi]$. D. Judge and J. T. Lewis (Dublin Inst. for Advanced Studies). Phys. Letters, 5: 190(July 1, 1963). (In English)

It is shown that the classical φ cannot be taken as an angle observable in quantum mechanics multiplication. Instead some $Y(\varphi)$ that is just $\varphi(\mathrm{mod}\ 2\pi)$ in the range $[-\pi,\pi]$ must be used. The commutation relation for L_z and $Y\varphi$ in the $Y(\varphi)$ representation is given. The meaning of its equivalent, the $[L_z,\varphi]$ commutator, is also discussed. (D.C.W.)

31168 DEGREE OF COHERENCE OF THE ELECTROMAGNETIC FIELD. B. Karczewski (Univ. of Rochester, N. Y.). Phys. Letters, 5: 191-2(July 1, 1963). (In English)

The vector (rather than the usual scalar) description of coherence properties of the electromagnetic field is considered. Only quasimonochromatic stationary electromagnetic fields are discussed. A general interference law for the electromagnetic field (similar in form to the scalar law) is derived. An expression for the degree of coherence of the field is obtained and is observed to be a generalization of the scalar degree of coherence. (D.C.W.)

31169 ON THE VALIDITY OF THE KUBO FORMULAE FOR TRANSPORT COEFFICIENTS. E. G. D. Cohen and M. H. J. J. Ernst (Universiteit, Amsterdam). Phys. Letters, 5: 192-4(July 1, 1963). (In English)

Attempts have been made to express transport coefficients in terms of time correlation functions. The validity of these expressions is examined by studying the viscosity coefficient of a diffuse simple gas in classical theory. In the lowest order of density the viscosity relation reduces to the Chapman-Enskog result. In the next order, however, a mechanism of momentum transport is not accounted for in the relation. Calculated results show that the viscosity relation does not correspond to that experimentally observed. (D.C.W.)

31170 SPECIFIC HEAT OF THE MANY-BOSON GAS. Robert Brout (Université Libre, Brussels). Phys. Rev., 131: 899-900(Aug. 1, 1963).

It is shown that the simple Hartree-Fock approximation to the free energy of a many-boson gas changes the Bose-Einstein condensation from a third- to a second-order transition. A term is added to the energy of the interaction system which is proportional to the specific heat of the ideal gas system. Quantitative estimates of the effect for liquid helium give an order of magnitude about 5 times too high, which shows the importance of the effect and the necessity for screening it out. (auth)

31171 SPIN-LATTICE RELAXATION AND SELF-DIFFUSION IN LIQUID He^3. J. R. Gaines, K. Luszczynski, and R. E. Norberg (Washington Univ., St. Louis). Phys. Rev., 131: 901-6(Aug. 1, 1963).

The spin-lattice relaxation time T_1 and the coefficient of self-diffusion D were measured in liquid He^3 in the temperature range between 0.35 and 3°K at SVP. Pulsed nuclear magnetic resonance in a field of 6800 G was used. The measured T_1, characteristic of bulk relaxation, was found to pass through a minimum value of about 290 sec in the vicinity of 1°K. Surface relaxation effects were examined, and possible explanations for the great diversity of the T_1 values reported in the literature are given. Certain details of experimental procedure are described. (auth)

31172 STATISTICAL MECHANICS OF He^3–He^4 LIQUID MIXTURES. Charles E. Hecht (Univ. of Chicago), Ryoichi Kikuchi, and Paul R. Stein. Phys. Rev., 131: 907-19(Aug. 1, 1963).

The partition function method proposed by Feynman for pure liquid He^4 and previously extended to treat pure liquid He^3 by Kikuchi is applied to liquid mixtures of He^3–He^4. The variation of the λ point with mole fraction He^3, the isotopic phase separation curve, and the excess functions of mixing are discussed. The theoretical λ line is interpreted as a cooperative boson transition and follows the experimental results closely up to $X_3 = 0.5$ irrespective of the effective mass of the He^3 atoms, while above $X_3 = 0.5$ the λ temperatures are too high. An asymmetric isotopic phase separation is found in the mixtures at temperatures below a critical temperature that depends slightly on further assumptions in the model but which is of the correct order of magnitude (1°K). The phase separation is due to the quantum dynamical effects as opposed to the purely statistical effects arising out of the different inherent symmetries of the wave functions for He^3 and He^4. The calculated excess Gibbs free energies of mixing become positive in "time" to effect the phase separation but are less positive than the experimental values and are in fact of the wrong sign above 1°K. The calculated excess entropies of mixing are much too positive. The model used assumes zero excess volumes of mixing. (auth)

31173 ORTHORHOMBIC ELECTRON SPIN RESONANCE SPECTRUM OF U^{3+} IN CaF_2. E. Mahlab (Hebrew

Univ., Jerusalem), V. Volterra, W. Low, and A. Yariv. Phys. Rev., 131: 920-2(Aug. 1, 1963).

An orthorhombic spectrum of U^{3+} in CaF_2 was measured. The orthorhombic X, Y axes are found to lie in the (110) plane and the Z axis perpendicular to these axes. The X axes are at ±(19 ± 1)° with the [110] direction. There are, in general, twelve inequivalent magnetic sites. The g factors corresponding to one set of axes are $g_x = 1.38 \pm 0.01$, $g_y = 2.85 \pm 0.02$, and $g_z = 2.94 \pm 0.01$. Various models explaining this spectrum are discussed. The most likely model is that of an interstitial F^- in the second nearest neighbor position. (auth)

31174 NEUTRON DIFFRACTION INVESTIGATION OF THE MAGNETIC PROPERTIES OF COMPOUNDS OF RARE-EARTH METALS WITH GROUP V ANIONS. H. R. Child, M. K. Wilkinson, J. W. Cable, W. C. Koehler, and E. O. Wollan (Oak Ridge National Lab., Tenn.). Phys. Rev., 131: 922-31(Aug. 1, 1963).

The magnetic properties of heavy rare-earth compounds with the NaCl-type structure have been investigated at temperatures between 295 and 1.3°K by neutron diffraction experiments on powdered specimens. All of the nitrides except TmN have a net ferromagnetism at low temperatures, but the diffraction patterns indicate a complicated type of magnetic order. HoP also has an unusual magnetic structure at low temperatures and this structure is presumably stabilized by dipole forces. The other phosphides, antimonides, and arsenides were found to have magnetic ordering transitions to the Mn-O type of antiferromagnetic structure. Low values of the atomic moments and large magnetic anisotropies in the ordered magnetic structures indicate the effects of crystal field interactions at low temperatures. (auth)

31175 MAGNETIC ORDERING PROPERTIES OF RARE-EARTH IONS IN STRONG CUBIC CRYSTAL FIELDS. G. T. Trammell (Rice Univ., Houston, Tex.). Phys. Rev., 131: 932-48(Aug. 1, 1963). (TID-18811)

A theoretical discussion of some of the effects resulting from the interplay between strong crystalline field torques and weaker exchange torques acting on rare-earth ions is given. The crystalline field is supposed to have cubic symmetry. A semiclassical discussion of the effect of the crystalline field in determining easy directions, anisotropy, and the depression of ground-state ordered moment values for the rare-earth series is given and used to interpret the results of the exact calculations. It is shown that for some of the rare earths the crystalline field may be so large that no long-range magnetic order is possible at low temperatures. The theory is applied to the case of the rare-earth phosphides. Adjusting the exchange and crystalline field parameters to yield the observed ordered moment values (and moment directions) of TbP and ErP, one predicts the HoP moment in agreement with the experimental value, and predicts that TmP will not order at all. The "holmium flopside" moment pattern is explained as being due to magnetic dipole forces. The ratio of the sixth-order component of the crystalline potential to the fourth-order component must be increased some five times over the naively computed value in order to reach agreement with experiment; however, an experimental indication of a possibly important noncubic component of the crystalline potential may change this value appreciably. (auth)

31176 MOMENTUM AUTOCORRELATION FUNCTIONS AND ENERGY TRANSPORT IN HARMONIC CRYSTALS CONTAINING ISOTOPIC DEFECTS. Robert J. Rubin (National Bureau of Standards, Washington, D. C.). Phys. Rev., 131: 964-89(Aug. 1, 1963).

The effect of isotopic defects on the decay of the momentum autocorrelation function and on the transport of energy in a harmonic crystal is investigated. A spectral representation is obtained for the classical momentum autocorrelation function of particle j, $\rho_{jj}(t)$. The spectral density is directly related to the normal mode frequency spectrum of the crystal. The recent investigations of $\rho_{jj}(t)$ in a perfect one-dimensional crystal and a one-defect one-dimensional crystal are discussed as special cases of this general Wiener-Khinchin formula. The quantum mechanical momentum autocorrelation function of the defect particle in a one-defect crystal is treated in detail for the case in which the defect particle is very heavy. The explicit results obtained are of interest in the theory of Brownian motion. A formal relation expressing the average momentum autocorrelation function in an isotopically disordered crystal as the cosine transform of the frequency spectrum of the crystal is derived. The energy transport property is studied in terms of $\{p^2[j,t]\}$, the time dependent ensemble average dispersion of the momentum of lattice particle j when the crystal is divided initially into two regions characterized by different temperatures. A simple identity is derived, which expresses $\{p^2[j,t]\}$ in terms of the solution of a particular initial value problem of the crystal lattice equations of motion. The local temperature at lattice site j, which is related to the momentum dispersion by means of the definition $\{p^2[j,t]\} = M_j k_B T[j,t]$, is determined analytically in the case of the perfect and the one-defect one-dimensional crystals. The local temperature is determined numerically with the aid of an IBM-7090 computer for five isotopically disordered 100-particle one-dimensional crystals. (auth)

31177 OPTICAL ABSORPTION SPECTRUM OF Nd^{3+}-DOPED LaF_3 SINGLE CRYSTAL: THE EVIDENCE OF A HIDDEN SELECTION RULE. Eugene Y. Wong, Oscar M. Stafsudd, and David R. Johnston (Univ. of California, Los Angeles). Phys. Rev., 131: 990-2(Aug. 1, 1963).

The symmetry of the La^{6+} site in LaF_3 has been determined by x-ray and paramagnetic resonance. The x-ray results show a C_{2v} site symmetry in agreement with paramagnetic resonance. The optical absorption spectrum shows conclusive evidence of a selection rule contrary to the fact that a C_{2v} site symmetry gives no selection rule. Hence, there exists a hidden selection rule. (auth)

31178 COUPLED ELECTRON-PHONON SYSTEM. S. Engelsberg (Princeton Univ., N. J.) and J. R. Schrieffer. Phys. Rev., 131: 993-1008(Aug. 1, 1963).

The coupled electron-phonon system is considered for phonon spectra of Einstein and Debye forms. The single-particle electron Green's function G is calculated in a nonperturbative manner in both models, and its spectral weight function is examined to determine the validity of a quasiparticle picture. The weight function and the poles of G both lead to several branches of excitations rather than a single "dressed" electron. The asymptotic time dependence of the G is found, and the effect of multiphonon processes on the electron decay rate is discussed. The electronic polarizability, P, of the interacting system is calculated with the aid of a generalized Ward's identity for the electron-phonon vertex. This identity, which is a consequence of electronic charge conservation, is derived in an Appendix. The calculation of P is carried out in the limit that the Fermi velocity is small compared with the phase velocity of the polarization field. An Appendix on the formal development of the Green's function equations is included. (auth)

31179 DYNAMICAL MOTION AND GAMMA-RAY CROSS SECTION OF AN IMPURITY NUCLEUS IN A CRYSTAL. I. ISOLATED IMPURITIES IN GERMANIUM AND ALUMINUM. G. W. Lehman and R. E. DeWames (North American Aviation, Inc., Canoga Park, Calif.). Phys. Rev., 131: 1008-22(Aug. 1, 1963).

The general theory of the dynamical motion and gamma-ray cross section for a single impurity nucleus harmonically coupled to an arbitrary collection of N atoms is developed in supermatrix representation. The relevant properties of the system are expressed in terms of a functional matrix $f_0(\Omega)$ of order 3N × 3N, where Ω is the mass-reduced force-constant matrix. Our approach is to use a Cauchy singular integral representation for $f_0(\Omega)$ involving an integration along the real frequency, ω, axis. Matrix partitioning techniques are used to reduce our problem to one of evaluating the 3 × 3 impurity atom dynamic response matrix, $\{G\}_{11} = (1 + \epsilon)[I_3 + \tau\epsilon A_{11}]^{-1}A_{11}$, where $\tau = \omega^2 - i\delta$. Here, δ is an arbitrarily small number, and ε + 1 = ratio of impurity atom to host atom mass, (M_I/M_H). For an arbitrary physical arrangement of the atoms, $A_{11} = \{[I_{3(z+1)} - D_{z+1}(\Delta F/M_H)]^{-1}D_{z+1}\}_{11}$, where the subscript, 1, refers to the impurity atom coordinates, ΔF is the perturbation in force-constant matrix, and z is the number of sites over which the perturbation extends. The D_{z+1} matrix has matrix elements obtained from the elements of the pure host matrix $D_H = [\tau I_{3N} - F_H M_H^{-1}]^{-1}$, F_H is the pure host force-constant matrix. I_k is a k × k unit matrix. The general approach is used to study the dynamic response of an impurity atom substituted in the aluminum lattice with arbitrary ε and nearest neighbor ΔF. The A matrix is block diagonalized by introducing the molecular vibration symmetry coordinates and A_{11} is characterized by a 4 × 4 symmetry adapted Green's function matrix whose elements have been tabulated. A generalized tensor force-constant model is used with Walker's force constants characterizing D_H, the pure aluminum lattice Green's function matrix. Similar studies are carried out for a Sn^{119} atom isotopically substituted in Ge, where the relevant Green's functions are derived from Phillip's frequency spectrum. The dynamical motion and gamma-ray cross section of impurity nuclei are characterized by a dynamic response function, K, which is related to the imaginary part of $\{G\}_{11}$. Typical K functions are presented for Fe^{57} in Al for various changes in ΔF and for Sn^{119} in Ge with ΔF = 0. The results show that the dynamical behavior of impurity atoms in real lattices is quite sensitive to the vibrational properties of the host lattice. The resonant fraction of γ rays absorbed by the impurity nucleus, *f*, the Lamb-Mössbauer coefficient, 2W, and mean-square velocity, $(v_I^2)_{av}$, of Fe^{57}-Al are tabulated for several ΔF changes as a function of temperature. The results are extrapolated to study the temperature dependence of 2W and *f* for Fe^{57}-Cu and Fe^{57}-Pt. From the results derived, it is possible to determine K, 2W, and $(v_I^2)_{av}$ for any ε and ΔF for Al as a host lattice. (auth)

31180 LONG LIFETIME OF POSITRONS IN IONIC CRYSTALS. A. Bisi, A. Fiorentini, and L. Zappa (Istituto di Fisica del Politecnico, Milan). Phys. Rev., 131: 1023-4(Aug. 1, 1963).

The time-annihilation spectrum of positrons in some ionic crystals was found to be complex. In alkali chlorides, besides the short-lifetime component typical of free-positron annihilation, the spectrum displays a long-lifetime component having a relative intensity of about 25% and a mean life ranging from 4.3×10^{-10} sec (LiCl) to 6.4×10^{-10} sec (CsCl). A linear dependence appears to occur between the long-lifetime annihilation rate and the molecular density. In lithium hydride the long-lifetime component exhibits a relative intensity of 12% and a mean life of 1.5×10^{-9} sec. Taking into account the difficulties faced by assuming positronium formation in ionic crystals, an attempt is made to interpret our results on the basis of the existence of positron compounds, like that of Wheeler (Cl^-e^+) and that of Ore (H^-e^+). (auth)

31181 LATTICE DYNAMICS OF ALKALI HALIDE CRYSTALS. II. EXPERIMENTAL STUDIES OF KBr AND NaI. A. D. B. Woods (Atomic Energy of Canada Ltd., Chalk River, Ont.), B. N. Brockhouse, R. A. Cowley, and W. Cochran. Phys. Rev., 131: 1025-9(Aug. 1, 1963).

Dispersion curves for the lattice vibrations propagating in the [00ξ], [ξξ0], and [ξξξ] directions in NaI at 100°K and in KBr at 90°K have been measured using neutron spectrometry, and the results compared with calculations based on a simple shell model. Both substances obey the Lyddane-Sachs-Teller relation. In addition, some measurements were made on KBr at 400°K; most frequencies showed a decrease of a few percent. At this temperature, the acoustical modes show no significant energy broadening, the transverse optical modes show slight broadening, and the longitudinal optical modes show very considerable broadening. The anomalous broadening of the LO modes is not yet understood and requires further study. It appears to be specimen dependent as well as temperature dependent. (auth)

31182 LATTICE DYNAMICS OF ALKALI HALIDE CRYSTALS. III. THEORETICAL. R. W. Cowley (Cambridge Univ., Eng.), W. Cochran, B. N. Brockhouse, and A. D. B. Woods. Phys. Rev., 131: 1030-9(Aug. 1, 1963).

The "shell model" of an alkali halide is extended to take into account short-range forces between both first- and second-nearest neighbor atoms in the crystal, the polarizability of both ions, and the possibility that the ionic charge may be less than one electronic charge. The arbitrary parameters of the model have been obtained by means of a least-squares fit to the measured dispersion relations for the lattice vibrations, the dielectric constants, and the elastic constants. For NaI and KBr, models have been found which give excellent agreement both with these measurements and with measurements of the specific heat. This good agreement is, however, obtained only when the simple shell-model concept of the ions is to some extent abandoned. The reasons for this, and the connection with work of other authors, are discussed. (auth)

31183 OBSERVATION OF A POSSIBLE LARGE CRYSTALLINE STARK SPLITTING IN METALLIC Ce: $LaAl_2$. J. A. White (Yale Univ., New Haven), H. J. Williams, J. H. Wernick, and R. C. Sherwood. Phys. Rev., 131: 1039-42(Aug. 1, 1963).

The susceptibility of polycrystalline $Ce_xLa_{1-x}Al_2$ with several different concentrations of cerium has been found to decrease to about one fourth the value for free-Ce^{3+} ions between room temperature and 4.2°K. The observed behavior is consistent with a cubic-crystal field splitting in the $J = 5/2$ ground term of Ce^{3+} of 200°K. The observed splitting is close to that predicted on a point-charge ionic model ignoring shielding by conduction electrons if the rare-earth ions are assumed to be tripositive and the aluminums negative, and if the 4*f* electron of Ce^{3+} is represented by a Hartree-Fock function. It is about one third as large as might have been expected on the basis of experience with cubic nonconductors had the Ce: $LaAl_2$ been a nonconductor with this distribution of charges rather than a conductor. (auth)

31184 SPIN-WAVE THEORY OF MAGNETIC RESONANCE IN SPIRAL SPIN STRUCTURES: EFFECT OF AN

APPLIED FIELD. B. R. Cooper (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and R. J. Elliott. Phys. Rev., 131: 1043-56(Aug. 1, 1963).

The possibility of performing magnetic resonance experiments in substances with spiral spin structures is studied. Particular attention is paid to the variation of spin arrangement and spin-wave spectrum with an applied magnetic field in the plane of the spiral. Perturbation techniques give resonance frequencies for small fields and for fields near the value, H_f, required for ferromagnetic alignment. These results then allow a realistic extrapolation for the whole range of H. The effects of planar anisotropy and demagnetizing fields on the variation of spin arrangement and on the spin-wave frequencies are discussed. The actual conditions of resonance are examined for dysprosium and erbium. There is a discussion of the information that can be obtained from polycrystalline specimens with particular reference to the experimental results for $MnAu_2$. (auth)

31185 EXCITED STATES OF THE F CENTER. Clifford C. Klick and Milton N. Kabler (Naval Research Lab., Washington, D. C.). Phys. Rev., 131: 1075-9(Aug. 1, 1963).

Various L bands have been measured in KCl and KBr x-rayed at liquid-helium temperature and in KCl : H x-rayed at room temperature. These results argue against the suggestion that the L bands arise from complexes involving F centers and support the argument that the L bands arise from the F center itself. A charge-transfer model of the L bands is proposed in which the transitions correspond to a combination of transferring the F-center electron to a neighboring alkali ion and raising the resulting alkali atom to one of its excited states. (auth)

31186 MAGNETIC STUDY OF THE LIGHTER RARE-EARTH IONS IN THE IRON GARNETS. S. Geller, H. J. Williams, R. C. Sherwood, J. P. Remeika, and G. P. Espinosa (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 131: 1080-2(Aug. 1, 1963).

The magnetic behavior of the trivalent ions of La, Pr, Sm, and Eu in the iron garnets in the range 0 to 298°K has been determined, that of the Nd^{3+} ion having been reported earlier. The diamagnetic ion La^{3+} behaves similarly to Y^{3+}. An applied field of about 70 kOe appears to produce magnetic saturation of $\{Y_2Pr\}Fe_2Fe_3O_{12}$ at 4.2°K, the contribution of the Pr^{3+} ion being 1.6 μ_B at this temperature. The Sm^{3+} ion introduces large anisotropy but spherical crystals of samarium iron garnet allowed to move freely in the applied field leads to saturation at relatively low fields. The Sm^{3+} ion contributes a moment of 0.14μ_B at 0°K to the net magnetization and behaves similarly to the Pr^{3+} and Nd^{3+} ions at temperatures below 298°K in that its moment adds to that of the resultant of the iron sublattice moments. Results of measurements of a single-crystal sphere of europium iron garnet are in agreement with those made on a polycrystalline specimen by Villers et al. (auth)

31187 TUNNELING FROM A MANY-PARTICLE POINT OF VIEW. Richard E. Prange (Univ. of Maryland, College Park). Phys. Rev., 131: 1083-6(Aug. 1, 1963).

The Hamiltonian for a system of interacting electrons in the presence of a barrier is transformed into one which can be separated into three parts. Two of the parts describe the electrons on the "right" and "left" sides of the barrier, while the third is a transition term which allows tunneling through the barrier. It is shown that it is not reasonable to make the "right"- and "left"-hand hamiltonians commute, but the effect of this failure is easily accounted for in perturbation theory. In addition, corrections to the transition operator arising from interelectronic interaction are written down and discussed briefly. They may be both quantitatively and qualitatively important. (auth)

31188 RESONANT AMPLIFICATION OF SOUND BY CONDUCTION ELECTRONS. Shulamith G. Eckstein (Argonne National Lab., Ill.). Phys. Rev., 131: 1087-1101 (Aug. 1, 1963). (TID-18354; UAC-7236)

A Boltzmann equation technique is used to calculate the angular distribution of sound amplified by conduction electrons under various conditions. It was found that if v_d is the drift velocity of the electrons, and $\hat{q}$ a unit vector in the direction of propagation of sound, amplification occurs for all $\hat{q}$ such that $\hat{q} \cdot v_d > v_s$, where v_s is the velocity of sound. Resonance peaks in the amplification occur at certain directions of propagation. For a semimetal in crossed electric and magnetic fields resonant amplification occurs when $\hat{q} \cdot v_d - v_F(\hat{q} \cdot \hat{H}) \approx v_s$ (where $\hat{H}$ is a unit vector in the direction of the magnetic field, and v_F the Fermi velocity) if $ql \gg 1$, where l is the mean free path of the electrons and q the wave number of the sound wave; if $ql \ll 1$ resonance peaks occur for $\hat{q} \cdot v_d \approx v_s$. The peak amplification is rather insensitive to the value of v_d/v_s, and varies with frequency as ql. For a metal or semiconductor in an applied electric field only, resonant amplification occurs for those directions of propagation such that $\hat{q} \cdot v_d \approx v_s$, if $ql \ll 1$, and the peak amplification is independent of v_d/v_s. There are no resonances in this case of $ql \gg 1$. (auth)

31189 ISOTOPE EFFECT IN SUPERCONDUCTING OSMIUM. R. A. Hein and J. W. Gibson (Naval Research Lab., Washington, D. C.). Phys. Rev., 131: 1105-10 (Aug. 1, 1963).

An experimental study of the relative critical-magnetic-field curves of three isotopically enriched and one natural sample of osmium has been carried out between 0.08 and 0.675°K. Temperatures below 1°K were produced by the magnetic cooling-method and superconductivity was detected by means of a dc mutual-inductance method. Data were obtained by first cooling, in the same experiment, three osmium samples to a temperature of approximately 0.08°K and then observing, independently, their differential magnetic susceptibilities, as the samples slowly warmed up in the presence of an externally applied magnetic field. In this manner, one obtains differences in the transition temperatures (ΔT_c) as a function of the critical magnetic field H_c. These data show that the critical-magnetic-field curves of the four samples are indeed distinct. Deviations of the critical-magnetic-field curves from the parabolic law are consistent with the Bardeen, Cooper, Schrieffer (BCS) theory of superconductivity. For the natural sample the quantity $H_c/H_0 - [1 - (T/T_0)^2]$ attains a maximum value of −0.037 at a value for $(T/T_0)^2$ of 0.52. Here H_c is the measured critical magnetic field, H_0(=80.4 G) is the critical magnetic field at absolute zero, and T_0(=0.671°K) is the transition temperature in zero magnetic field. The other samples exhibited deviations from the appropriate parabolas which range from 0.037 to 0.041. The values of γ, the electronic specific heat coefficient for the four samples, are found to lie in the range of $(4.77 \pm 0.07) \times 10^{-4}$ cal/mole-deg^2. Magnetically induced superconducting to normal-state transitions indicated that all of these samples displayed good "Meissner" properties. In view of this and the fact that the sample with the heavier mass $\overline{M}$ possesses the lower critical-magnetic-field curve, it is concluded that an isotope effect does exist in Os. The data suggest that the effect be represented by the relationship $T_0 \sim \overline{M}^{-0.21}$. (auth)

31190 LUMINESCENCE OF PURE AND Cu-DOPED ALKALI HALIDE SINGLE CRYSTALS. R. Oggioni and G. Spinolo (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Phys. Rev., 131: 1114-17(Aug. 1, 1963).

In order to understand some x-ray excited emission bands in pure alkali halides, crystals were doped with the corresponding copper halides. It has been found that a band, which is also often present in "pure" or thermally treated alkali halides, is due to a Cu center. The excitation spectrum of the Cu impurity at room temperature has also been measured. It is shown that the radiative transitions connected with Cu centers involve electrons. (auth)

31191 PROTON MOTION, KNIGHT SHIFTS, AND QUADRUPOLAR EFFECTS IN THE LANTHANUM–HYDROGEN SYSTEM. D. S. Scheiber and R. M. Cotts (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 131: 1118-32 (Aug. 1, 1963).

The nuclear magnetic resonance of both the lanthanum and hydrogen nuclei in the lanthanum–hydrogen system has been studied as a function of hydrogen concentration and temperature. The concentrations ranged from 0.4 H/La to 2.85 H/La and temperatures –197°C to 400°C. The existence of two phases, part La metal and part $LaH_{2.0}$ for concentrations with less than 2 H/La, is confirmed. Measurements of the proton linewidth and thermal relaxation time T_1 unambiguously demonstrate that proton self-diffusion takes place at moderate temperatures. Activation energies and attempt frequencies for the proton self-diffusion, which are determined as a function of hydrogen concentration, decrease abruptly at ≈2 H/La from 23 kcal/mole and 10^{14} sec^{-1}, respectively, to 3 kcal/mole and 10^{11} sec^{-1} at 2.85 H/La. The proton static linewidths vary continuously from 7.8 g at 2 H/La to 12.4 g at 2.85 H/La and the proton T_1 has a characteristic self-diffusion induced minimum of ≈5 to 8 msec and a maximum of ≈100 msec where spin diffusion to paramagnetic impurities dominates. The self-diffusing protons have a pronounced effect, via a quadrupole interaction, on the La resonances. For hydrogen concentrations slightly greater than 2 H/La, a broadening and then narrowing again of the La linewidth, and a decrease with a subsequent recovery of the La Knight shift is observed as the proton self-diffusion rate increases with temperature. For concentrations greater than 2.4 H/La, no La resonance is observed until a sufficiently high proton self-diffusion rate is attained to average out the quadrupolar effects. A detailed semiquantitative analysis incorporating the proton resonance data is made of these quadrupolar effects. At 400°C the La Knight shift is found to decrease from 0.23% for 2 H/La to 0.10% for 2.85 H/La

le no Knight shift is observed for the proton resonance at any concentration or temperature. The thermal relaxation time of the La resonance in $LaH_{2.0}$ is found to be the result of a conduction electron hyperfine interaction with T_1T = 11.3 sec °K when the protons are static. With proton motion the La T_1 decreases exponentially to a value somewhat greater than the La T_2 or about 100 μsec at 400°C. A schematic picture of the band structure of the hydride consistent with the available data is suggested, based on an ionized hydrogen atom or proton, whose electron goes into a conduction band localized on the La ion. (auth)

31192 EMPIRICAL ANALYSIS OF THE H^- PHOTODETACHMENT CROSS SECTION. Baxter H. Armstrong (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev., 131: 1132-7(Aug. 1, 1963).

The zero-range photoelectric cross section of Bethe and Peierls, corrected according to effective range theory, is fitted to the H^- photodetachment cross section. The value of 2.64 a_0 obtained for the effective range agrees with values obtained from the wave-function calculations of Schwartz, Burke and Schey, and others. A more accurate formula for the detachment cross section is obtained by allowing for distortion in the final p state by means of an approximate formula for the phase shift. This formula agrees qualitatively with the close-coupling theory phase-shift results of Burke and Schey, and provides a photodetachment cross section that fits the experimental data slightly better than the results recently obtained by Geltman with an elaborate variational treatment. There are two adjustable parameters: the binding energy, and one parameter in the phase-shift formula. By a slightly different choice of the parameters than is required to fit the experimental data, close agreement can also be obtained with the Geltman results. (auth)

31193 IMPULSIVE COLLISION MODEL FOR THE DISSOCIATION OF DIATOMIC MOLECULES. Thor A. Bak (Universitet, Copenhagen) and Joel L. Lebowitz. Phys. Rev., 131: 1138-48(Aug. 1, 1963).

The dissociation rate of a dilute solution of diatomic molecules in an inert gas was studied. The diatomic molecule is assumed to dissociate when its vibrational energy exceeds the dissociation energy E. A classical impulsive collision model is used for the interaction between the diatomic molecules and the solvent gas which is treated as a temperature bath at temperature T. The diatomic molecule is also simplified by treating it as one dimensional, thus neglecting the rotational degrees of freedom, and assuming that its translational degree of freedom is always in equilibrium when it is not neglected entirely. Still further simplification is achieved by considering only cases where the effect of the solvent gas may be represented by a transition rate between the vibrational energy states of the diatomic molecule, and the distribution function for vibrational energies $\epsilon \lesssim E$ is approximately given by the equilibrium distribution $F_0(\epsilon)$. It is found generally (i.e., when the assumptions stated in the last sentence hold, but independent of our model) that when a diatomic molecule with vibrational energy E is very likely to lose (rather than gain) energy in a collision with a gas atom, the dissociation rate k(E) is given by the expression $k(E) = \beta^{-1}[\tau(E)]^{-1}F_0(E)$, where $\tau(E)$ is the mean time between collisions for a molecule with vibrational energy E and β^{-1} is Boltzmann's constant times T. For the model considered, this is the case when $E \gg (\gamma\beta)^{-1}$ where γ is the ratio of the mass of a gas atom to that of a diatomic molecule. The expression for k(E) then assumes the simple form, $k(E) = \alpha Ac\beta^{-1}e^{-\beta E}[\mathcal{N}(E)/Z(E)]$, where A is the cross-sectional area for a collision, c is the concentration of gas atoms, Z(E) is the vibrational partition function for the bound states, $\mathcal{N}(E)$ is the distance between the minimum and maximum value of the vibrational coordinate when the molecule is on the threshold of dissociation, and α is a constant of order unity. The case when $\gamma \ll 1$ is also treated, which leads to a Fokker-Planck type equation for the distribution function from which k(E) is found for $\beta E \gg 1$. A quasiquantum-mechanical calculation for k(E) is also presented and leads to the same results as the classical calculation. (auth)

31194 THEORY OF NUCLEAR MAGNETIC RELAXATION BY SPIN-ROTATIONAL INTERACTIONS IN LIQUIDS. Paul S. Hubbard (Univ. of North Carolina, Chapel Hill). Phys. Rev., 131: 1155-65(Aug. 1, 1963).

The contribution of spin-rotational interactions to the nuclear magnetic relaxation of identical spin-½ nuclei at

equivalent positions in spherical liquid molecules is calculated by use of the semiclassical form of the density-operator theory of relaxation, and the result is compared with the contributions of intra- and intermolecular dipole-dipole interactions. The angular velocity of a molecule is treated classically by assuming that it obeys an equation analogous to the Langevin equation that is postulated in treatments of translational Brownian motion. The change in orientation of a molecule is assumed to be due to isotropic rotational Brownian motion. By use of this model the correlation functions of components of the angular velocity of a molecule are calculated, and are found to have an exponentially decaying time dependence with a time constant (correlation time) τ_1 that is quite different in its temperature dependence than the correlation time τ_2 of the dipole-dipole interactions. In typical situations τ_1 is much smaller than τ_2. Use is made of this fact to evaluate the correlation functions of the functions of the orientation and angular velocity that occur in the tensor spin-rotational interactions. The result that $\tau_1 \ll \tau_2$ explains the experimentally observed "quenching" of the relaxation effect of spin-rotational interactions in liquids, and the result that $\tau_1 T$ increases as the temperature increases explains the experimentally observed temperature dependence of the relaxation effect of spin-rotational interactions in liquids. (auth)

31195 L-SHELL FLUORESCENCE YIELDS IN HEAVY ELEMENTS. R. C. Jopson, Hans Mark, C. D. Swift, and M. A. Williamson (Univ. of California, Livermore). Phys. Rev., 131: 1165-9(Aug. 1, 1963). (UCRL-6954)

Partial L-shell fluorescence yields of 23 heavy elements have been measured using an x-ray coincidence counting method. Vacancies in the K shell of the target atoms are created by photoelectric absorption of 122- and 136-kev gamma rays emitted by a Co^{57} source. A known fraction of these K-shell vacancies are filled by L electrons. The L-shell vacancies created in this way are then occupied by electrons from higher shells, causing emission of L x rays and Auger electrons. The coincidence rate between the L and K x rays determines the fluorescence yield ω_{KL}, which is defined as the partial L-shell fluorescence yield following the emission of K_α x rays. ω_{KL} is a linear combination of the fluorescence yields of the L_{II} and L_{III} subshells. A comprehensive comparison with previous measurements is given. (auth)

31196 CORRELATION EFFECTS IN TWO- AND THREE-ELECTRON SYSTEMS. John W. Cooper and Jerry B. Martin (National Bureau of Standards, Washington, D. C.). Phys. Rev., 131: 1183-6(Aug. 1, 1963).

Correlation effects in the lithium isoelectronic series $(1s)^2 2s^2 S$ have been studied by computing the expectation values of a number of one- and two-electron operators. Calculations were performed using both Hartree-Fock and configuration interaction wave functions. The operators considered are Σr_i^N (N = −2, −1, 2, 4), $\Sigma\delta^3(r_i)$, Σp_i^2, $\Sigma_{i>j}\delta^3(r_{ij})$, $\Sigma_{i>j}(r_i \cdot r_j)$, and $\Sigma_{i>j}(p_i \cdot p_j)$. Computations were performed for Z = 3, 4, 5, and 8. For comparison purposes the same expectation values were computed from configuration interaction wave functions of comparable accuracy for the two-electron systems $(1s)^2\,{}^1S$ with Z = 2, 3, 4, 5, and 8. The results of the two-electron computations show reasonable agreement with more accurate computations and with empirical estimates. For the three-electron systems the main conclusions are: (a) Correlation has little effect on the one-electron expectation values, (b) the expectation values of $\Sigma_{i>j}(r_i \cdot r_j)$ and $\Sigma_{i>j}(p_i \cdot p_j)$ are proportionately larger for three- than for two-electron systems, and (c) the configuration interaction approach probably gives poor estimates of the expectation value of $\Sigma_{i>j}\delta^3(r_{ij})$ even though this value appears to converge as the number of terms in the wave function is increased. (auth)

31197 NUCLEAR SPIN-LATTICE RELAXATION IN HYDROGEN GAS. M. Lipsicas and A. Hartland (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 131: 1187-93 (Aug. 1, 1963).

The proton spin-lattice relaxation time, T_1, for hydrogen gas has been measured, using pulse techniques, as a function of gas density, ρ, temperature, and orthohydrogen concentration. The maximum density investigated was of order 900 amagats and the temperature range extended from 20 to 400°K. The radial dependence of the anisotropic part of the intermolecular potential due to the interaction of two hydrogen molecules has been deduced from a comparison of the temperature dependence of T_1/ρ in the dilute gas above 80°K with some calculations based on the theory of Oppenheim and Bloom. It is, approximately, an inverse thirteenth power of the intermolecular separation for the ortho-para interaction and an inverse sixth power for the ortho-ortho interaction. The results above 80°K are found to be sensitive to quantum-mechanical diffraction effects, in the manner suggested by Lipsicas and Bloom, and the temperature independence of T_1/ρ for dilute normal hydrogen gas above 80°K is shown to result from the different radial dependence of the ortho-ortho and ortho-para interactions. The results for T_1 in the very dense gas appear to be consistent with the idea of a liquid-like assembly of molecules with predominantly short-range intermolecular interactions. Calculations are not available at the present time for comparison with any of the results below about 80°K, which are expected to be strongly influenced by quantum-mechanical effects. Some qualitative discussion is given of the dilute and dense gas results in this temperature range. At very low orthohydrogen concentrations, an unusual density dependence of T_1 is observed in the temperature range 34–42°K. It appears that this effect is connected with the critical temperature phenomena, but it is not understood at present. (auth)

31198 CHEMICAL POTENTIAL AND LOW-LYING EXCITATION IN THE MANY-BODY BOSE SYSTEM. Katuro Sawada and Ludwig W. Bruch (Univ. of California, San Diego). Phys. Rev., 131: 1379-83(Aug. 1, 1963).

For a Bose system interacting through a two-body potential there is a large occupation number in the zero-momentum state with small fluctuations. Thus, one can express the chemical potential and low-lying excitation energy in terms of the density fluctuation only. The formulas derived are shown to coincide with well-established results in the low-density Bose gas. The use of experimental neutron scattering data is suggested to improve the numerical answer. A particular application is made to the He^4 case. If one utilizes the Feynman variational excited state as the (approximate) true state vector, which is correct experimentally for low-momentum excitations, an explicit phonon excitation for actual He^4 is found. (auth)

31199 STUDY OF IRON IONS IN NaCl USING THE MÖSSBAUER EFFECT. I. THE $CoCl_2$ PRECIPITATED STATE. James G. Mullen (Argonne National Lab., Ill.). Phys. Rev., 131: 1410-14(Aug. 15, 1963).

Single crystals of $CoCl_2$ containing tracer Co^{57} were grown by precipitation within NaCl at low temperatures. The observed Mössbauer spectrum for Fe^{57} indicates an isomer shift of 1.32 ± 0.04 mm/sec above stainless steel and a quadrupole splitting of 1.14 ± 0.06 mm/sec at 80°K, which is significantly less than has been observed in ionic-

Fe^{2+} compounds. The small splitting can be largely explained by assuming a doubly degenerate ground state with the appropriate wave functions. The measured quadrupole splitting is reduced about 20% at room temperature which can be explained by arguments analogous to those used to interpret the temperature dependence of the splittings in iron compounds. The observed angular distribution of the intensities of the two lines demonstrates that the precipitated crystals near the surface are partially aligned in their spatial orientation. The data indicate only one charge state (Fe^{2+}), showing that higher charge states resulting from the emission of Auger electrons reach equilibrium in less than 10^{-7} sec. (auth)

31200 STUDY OF IRON IONS IN NaCl USING THE MÖSSBAUER EFFECT. II. THE VACANCY-IMPURITY ASSOCIATED STATE. James G. Mullen (Argonne National Lab., Ill.). Phys. Rev., 131: 1415-20(Aug. 15, 1963).

Two types of Mössbauer spectra were observed for dilute concentrations of Fe^{57} ions in NaCl. A doublet with a 0.5 mm/sec quadrupole splitting and a 0.5 mm/sec isomer shift relative to stainless steel (80°K) is interpreted as the result of either Fe^{2+} or Fe^{3+} associated with a positive ion vacancy. A broad unsplit line at -2.07 ± 0.07 mm/sec (80°K) is interpreted as the result of Fe^{+} substitutionally replacing Na^{+}. The data are used to make a rough estimate of the binding energy between positive ion vacancies and cobalt impurities, and the result is consistent with theoretical expectations. A study of the temperature dependence of these two resonances indicates that the ratio of the recoilless emitted γ rays from the isolated ions compared with the vacancy associated ions is 0.75 ± 0.15 at 80°K, 0.24 ± 0.08 at 296°K, and 0.16 ± 0.08 at 478°K. This huge effect is believed to be due to the difference in elastic constants and "mass-symmetry" contributions to the localized modes, for the two environments. (auth)

31201 INTERELECTRON SCATTERING IN QUASI-INTRINSIC GERMANIUM AND SILICON. E. G. Wikner and J. Pereue (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev., 131: 1466-8(Aug. 15, 1963).

The transient conductivity of germanium and silicon, induced by the generation of excess carriers by high-energy electrons, has been measured as a function of generation level. At the high generation levels (10^{16}–10^{17} carriers/cm^3), a striking reduction in the carrier mobility is observed both at 300 and 80°K. Specifically, for a generation level of $4 \times 10^{16}/cm^3$ in germanium at 80°K, the mobility is found to be decreased by a factor of 5 as a result of interelectron scattering. At 300°K, interelectron scattering is observed at higher generation levels because lattice scattering is relatively more important. A quantitative comparison with theory is made, with excellent agreement found. (auth)

31202 NUCLEAR MAGNETIC RESONANCE STUDY OF Al^{27} IN NiAl. J. A. Seitchik and R. H. Walmsley (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 131: 1473-7 (Aug. 15, 1963).

The NMR of Al^{27} has been studied in two samples of the bcc ordered alloy NiAl whose atomic compositions were 48% Ni, 52% Al and 50% Ni, 50% Al. The line intensity of the first sample is accounted for by assuming all satellite transitions wiped out by quadrupolar interactions with defects. The width of the observed $-\frac{1}{2} \rightleftharpoons \frac{1}{2}$ transition was 4.5 ± 0.3 Oe, field- and temperature-independent, and can be almost entirely accounted for by Al^{27} dipole-dipole interactions. The second sample had an 11% greater width and 85% greater intensity, indicating contributions from satellite transitions. The Knight shift of both samples was $0.055\% \pm 0.005\%$, which is only one-third that of pure aluminum, and was independent of magnetic field and temperature. The specific heat of NiAl was measured from 2.2°K to 4.2°K, giving $\gamma_{el} = 12.6 \times 10^3$ ergs $mole^{-1}$ $°K^{-2}$, which is 87% of the value for pure aluminum. It is concluded that the low value of the Knight shift results from a small Fermi-contact interaction at the aluminum sites for electrons at the Fermi surface and is not due to a low density of states. (auth)

31203 ULTRASONIC ATTENUATION IN SUPERCONDUCTORS FOR $ql < 1$. Moises Levy (Univ. of California, Los Angeles). Phys. Rev., 131: 1497-1500 (Aug. 15, 1963).

A derivation is given for the attenuation of both transverse and longitudinal ultrasonic waves in the superconducting state for the case when the product of the ultrasonic wave vector times the electron mean free path is smaller than one. It is assumed that the effect of electromagnetic fields is negligible in this frequency range. For transverse waves it is found that the ratio of the ultrasonic attenuation coefficient in the superconducting state and the normal state is equal to twice the Fermi function of the temperature-dependent superconducting energy gap, in agreement with experimental results obtained by Levy, Kagiwada, and Rudnick. The same result is obtained for longitudinal waves. (auth)

31204 PHONON SCATTERING BY LATTICE DEFECTS. Miles V. Klein (Univ. of Illinois, Urbana). Phys. Rev., 131: 1500-10(Aug. 15, 1963). (TID-18702)

The Green's-function matrix method first developed by I. M. Lifshitz is applied to the problem of the scattering of phonons by a localized perturbation in the lattice. The scattering can be described by a $\underline{t}$ matrix that is localized to the same extent as the perturbation and has similar symmetry properties. The $\underline{t}$ matrix can be written in terms of the perturbation matrix γ and the Green's function matrix $\underline{g}$, perhaps most easily in terms of the representation formed by the eigenvectors of the matrix $\underline{g}\gamma$, γ; these vectors can often be found by symmetry considerations. Two cases are of particular interest: (1) a "singular" perturbation which leads to a $\underline{t}$ matrix independent of the strength of the perturbation, and (2) resonance scattering from a low-frequency virtual local mode. The latter case is discussed for the example of decreased central-force constants between (100) nearest neighbors and the impurity site. Some implications for thermal conductivity are mentioned. (auth)

31205 MAGNETIC STRUCTURES OF CHROMIUM–MODIFIED Mn_2Sb. A. E. Austin (Battelle Memorial Inst., Columbus, Ohio), E. Adelson, and W. H. Cloud. Phys. Rev., 131: 1511-17(Aug. 15, 1963).

The magnetic structures of tetragonal chromium-modified Mn_2Sb have been determined by neutron-diffraction studies of single crystals. Compositions of $Mn_{2-x}Cr_xSb$ for $\underline{x}$ from 0.023 to 0.10 were examined. Three magnetic structures have been observed, depending upon composition and temperature. These all have antiferromagnetic coupling between manganese atoms Mn(I) in (a) sites of (0,0,0), ($\frac{1}{2}$,$\frac{1}{2}$,0), and Mn(II) in (c) sites of (0,$\frac{1}{2}$,$\underline{z}$), ($\frac{1}{2}$,0,$\underline{z}$). The high-temperature structure is that of ferrimagnetic Mn_2Sb where there is ferromagnetic coupling between successive layers of Mn(I) plus adjacent Mn(II) atoms. With decreasing temperature there is an exchange inversion to an antiferromagnetic coupling between successive layers giving a magnetic unit cell with a tetragonal axis twice that of the x-ray cell. For $\underline{x} = 0.03$ a new weakly ferrimagnetic state exists between the ferrimagnetic and antiferromagnetic states. The magnetic unit cell of this structure has a tetragonal axis three times that of the

x-ray cell. The spins are perpendicular to the c axis in this intermediate ferrimagnetic structure and in the antiferromagnetic state of the compositions studied. (auth)

31206 CORRELATION EFFECT ON THE NUCLEAR MAGNETIC RESONANCE LINEWIDTH IN MAGNETIC MATERIALS. P. Pincus (Univ. of California, Los Angeles). Phys. Rev., 131: 1530-2(Aug. 15, 1963).

In a magnetic medium the nuclear spins are coupled by the indirect Suhl-Nakamura interaction. This interaction contributes to the nuclear magnetic resonance (NMR) linewidth and gives rise to a shift in the NMR frequency which is important in the helium-temperature range for materials with a large concentration of nuclear spins and a large interaction range, b. When this frequency pulling is appreciable, there exists a relative narrowing of the NMR line of the same order of magnitude as the relative frequency shift. This narrowing arises because the motions of the nuclear spins within the interaction range, b, are correlated. (auth)

31207 SUPERCONDUCTIVITY WITH PAIRS IN A RELATIVE p WAVE. R. Balian (CEN, Saclay, France) and N. R. Werthamer. Phys. Rev., 131: 1553-64(Aug. 15, 1963).

In previous treatments of superconducting systems with attractive interactions acting in odd-angular-momentum partial waves, the correlated electron pairs were formed in only two components of a spin triplet. This oversight is corrected here by a more general variational treatment, allowing all three components. In the case of a p-wave interaction, the present state is proved to give the absolute minimum of the free energy. Its rotational degeneracy is discussed. The energy spectrum is found to be isotropic (provided the normal phase is also) with the usual gap, and so to be completely equivalent thermodynamically to the BCS state. The charge-density autocorrelation is also isotropic, and the charge-current correlation vanishes. The state exhibits the conventional Meissner effect, and cannot be experimentally distinguished from the BCS state by means of electromagnetic or tunneling measurements, acoustic attenuation, or nuclear magnetic resonance (NMR) relaxation times. The paramagnetic spin susceptibility decreases with temperature from its value in the normal phase to a limiting ratio of $^2/_3$, in good agreement with results deduced from Knight shift measurements on mercury and tin, and in contrast to the BCS prediction. However, the addition of impurities is found to reduce the critical temperature sharply (again in contrast to the BCS case). Thus the experimental observation of the p-wave pair state is expected to be difficult, and the agreement with Knight shift data is probably fortuitous. Finally, it is suggested that a similar effect in He^3 might explain why the predicted superfluid phase has not been observed. (auth)

31208 DIFFUSION NARROWING OF NUCLEAR MAGNETIC RESONANCE LINEWIDTH OF F^{19} IN $CaF_2:Sm^{2+}$. Wm. J. Veigele and A. W. Bevan, Jr. (Martin Co., Denver). Phys. Rev., 131: 1585-6(Aug. 15, 1963).

Nuclear magnetic resonance linewidths of F^{19} in a synthetic $CaF_2:Sm^{2+}$ single crystal and natural CaF_2 single crystals have been measured over a temperature range from 88 to 668°K and over a range of H_1 from 2.0 to 29 mG. Up to temperatures of about 400°K results are in agreement with existing theories of saturational narrowing. At higher temperatures the line narrowed in the samarium-doped crystal but not in the natural crystals. This narrowing was attributed to a decrease of the fluorine dipole interaction due to fluorine interstitial diffusion. An activation energy E = 0.26 ev was calculated. (auth)

31209 HYPERVIRIAL THEOREM FOR COLLISIONS BETWEEN ELECTRONS AND ATOMS. Michael B. McElroy and Joseph O. Hirschfelder (Univ. of Wisconsin, Madison). Phys. Rev., 131: 1589-95(Aug. 15, 1963).

The hypervirial theorem was first introduced for bound-state systems and subsequently extended to one-electron scattering problems. Electron-atom collisions are considered, and the appropriate form of the hypervirial theorem is derived. Its relation to the original formulation is discussed. Application is made to the electron-hydrogen problem. Both elastic and inelastic collisions are investigated. (auth)

31210 THEORY OF THE DYNAMICAL JAHN-TELLER EFFECT. John C. Slonczewski (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev., 131: 1596-1610(Aug. 15, 1963).

A theory is given of dynamical effects arising from configurational instability of the Jahn-Teller type due to electronic degeneracy in solid-state impurities or in molecules. The model assumes a bilinear interaction coupling one pair of degenerate electronic states to n pairs of degenerate normal coordinates of lattice vibration in a system possessing a threefold symmetry axis. It is shown that in the strong-coupling approximation two modes of collective motion may be distinguished. In the first mode, the collective energy is small, the collective motion is stabilized by elastic restoring forces, and one angular collective coordinate is separable. In the second mode of collective motion, the collective energy is large, the motion is stabilized by pseudocentrifugal forces, and an additional, pseudoradial collective coordinate is approximately separable. Approximate formulas are given for the energy levels and widths of the second mode. It is suggested that these levels might be observable in solids with appropriate impurities or in molecules. (auth)

31211 STOPPING CROSS SECTIONS OF SOME HYDROCARBON GASES FOR 40-250 Kev PROTONS AND HELIUM IONS. John T. Park and E. J. Zimmerman (Univ. of Nebraska, Lincoln). Phys. Rev., 131: 1611-18(Aug. 15, 1963).

The stopping cross sections of air, He, CH_4, C_2H_2, C_2H_4, C_3H_8, $(CH_2)_3$, and C_3H_6 have been measured for protons in the energy range 40 to 250 kev. The stopping cross sections of C_2H_4 and C_3H_8 were also measured for helium ions. The data are in good agreement with previous experimental work, and have standard deviations between 1.5 and 4%. They clearly demonstrate the failure of the Bragg rule of additivity for proton energies less than 150 kev. The helium-ion data indicate that the effect of chemical binding on stopping cross sections is unlikely to be any greater for incident helium ions than for incident protons at the same energy. (auth)

31212 NUCLEAR MAGNETIC RELAXATION BY HINDERED ROTATIONS. R. De Micheli, L. Giulotto, and G. F. Nardelli (Università, Pavia, Italy). Phys. Rev., 131: 1619-23(Aug. 15, 1963).

The problem of the nuclear magnetic relaxation (NMR) due to hindered rotations in a crystal is treated considering the simple case of diatomic molecules assuming two antiparallel equilibrium orientations. An average time, τ_0, during which the molecule oscillates around an equilibrium orientation, and a constant jumping time, τ_1, are introduced. The spectral density is calculated as a function of τ_1 and of $\tau = \tau_1 + \tau_0$. For $\tau_1 = 0$ the spectral density introduced by Bloembergen et al. is found if one assumes $\tau/2 = \tau_c$. For $\tau_1 \neq 0$ and for $\omega\tau \ll 1$ the spectral density diminishes as τ_1 increases. Correspondingly, the calcu-

lated T_1's are in general longer than those calculated according to Bloembergen et al. (auth)

31213 SELF-FIELD LIMITING OF JOSEPHSON TUNNELING OF SUPERCONDUCTING ELECTRON PAIRS. Richard A. Ferrell and Richard E. Prange (Univ. of Maryland, College Park). Phys. Rev. Letters, 10: 479-81 (June 1, 1963).

The Josephson current that flows at zero potential difference through a barrier between two superconductors is inhibited by external magnetic fields. The self magnetic fields set up by the current itself are shown to have detrimental effects also. In a junction whose smallest diameter exceeds a certain penetration distance λ_J, the current arises only from a fringe of width λ_J at the edge of the junction. The magnitude of the maximum current is reduced since the interior does not contribute to the Josephson effect. An estimate of λ_J is given. (D.C.W.)

31214 TUNNELING BETWEEN SUPERCONDUCTORS. Vinay Ambegaokar and Alexis Baratoff (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 10: 486-9(June 1, 1963).

Josephson's calculations showed that for two superconductors separated by an oxide there may exist an oscillating supercurrent of frequency 2e V/h (V is applied voltage) and a possible d-c supercurrent at zero voltage. The calculations are reproduced by the method of the thermodynamic Green's function that allows generalization to superconductors with strong electron-phonon coupling. A simple prediction for the temperature dependence of the d-c supercurrent is shown to follow from the theory. (D.C.W.)

31215 MAGNETIC SCATTERING OF NEUTRONS BY NONCOLLINEAR SPIN DENSITIES. M. Blume (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 10: 489-91(June 1, 1963). (BNL-6969)

The spin densities associated with magnetic ions in a ferromagnet are not necessarily collinear with the net magnetization. It is shown that neutron scattering techniques can be used to distinguish noncollinear densities from the usual densities. The generalizations of neutron scattering theory required to account for these phenomena are indicated, and the effect of noncollinear spin densities on certain measurements is considered. (D.C.W.)

31216 DOUBLE EXCITATION OF HELIUM BY ELECTRONIC IMPACT. Philip M. Becker and John S. Dahler (Univ. of Minnesota, Minneapolis). Phys. Rev. Letters, 10: 491-3(June 1, 1963).

The cross section for electron impact excitation of He to the doubly excited $(2p)^2\ ^3P_g$ state was calculated. This state is the lowest lying, doubly excited state that is stable to autoionization. The differential cross section results indicate that the scattered beam has an intensity maximum at right angles to the incident beam. The total cross section shows the fairly sharp peak and rapid decay with increased electron energy characteristic of exchange reactions. The transition cross section is compared with others. (D.C.W.)

31217 SUPERCONDUCTIVITY BELOW 20 MILLIDEGREES. R. A. Hein (Naval Research Lab., Washington, D. C.), J. W. Gibson and R. D. Blaugher. Phys. Rev. Letters, 10: 6-9(July 1, 1963).

Electronic specific-heat data indicated that the critical temperature of Mo–Nb should pass through a minimum near a $Nb_{0.30}Mo_{0.70}$ composition. Tests showed the alloy to be a superconductor with a zero-field transition temperature of 0.016°K. A stray magnetic field of 1.5 gauss was sufficient to suppress the superconductivity, and superconductivity was observed only when the sample was shielded. A d-c mutual inductance method was used to detect the transition. The magnitude of the critical magnetic fields was also examined. (D.C.W.)

31218 STATISTICAL BEHAVIOR OF FINITE ISOLATED SUPERFLUIDS. M. Rich and J. J. Griffin (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 19-21(July 1, 1963).

Attempts have been made to find an analog of the BCS theory of electronic superconductivity in nuclear systems. The inability of a finite isolated nucleus at fixed excitation energy to show the energy fluctuations inherent in a system characterized by temperature is shown to lead to differences between the statistical behavior based on a fixed-temperature and a fixed-energy system. (D.C.W.)

31219 NEGATIVE TEMPERATURE COEFFICIENTS OF ION-MOLECULE REACTIONS IN THE IONIZATION CHAMBER OF THE MASS SPECTROMETER. STATISTICAL CALCULATIONS BASED ON AN EXPERIMENTAL MODEL FOR THE VARIATION OF THE MICROSCOPIC REACTION CROSS-SECTION WITH RELATIVE VELOCITY. T. P. J. H. Babeliowsky and N. A. I. M. Boelrijk (F.O.M. Laboratorium voor Massascheiding, Amsterdam). Physica, 29: 405-16(May 1963).

A statistical calculation is given of the phenomenological cross section Q of ion-molecule reactions in the ionization chamber of a mass spectrometer, for the case where a sufficiently high repeller field is applied and the microscopic cross section is given by $\sigma(g) = (g_c/g - 1)\,\sigma_H$. g is the relative velocity, and g_c is the critical value of this velocity for which σ becomes zero. It is found that a negative temperature effect may be expected. The magnitude of the effect is calculated for three numerical cases. A graph is given of d(ln Q)/d(ln T) as a function of the dimensionless quantity $(\mu/2kT)^{1/2}\,g_c$, where μ is the reduced mass of the ion and the molecule. (auth)

31220 THERMAL DIFFUSION IN TERNARY MIXTURES. I. THEORY. F. Van der Valk (F.O.M. Laboratorium voor Massascheiding, Amsterdam). Physica, 29: 417-26(May 1963).

A relatively simple expression is derived for the thermal diffusion factor of two components i and j of a ternary mixture. The expression is valid for any ternary mixture. (auth)

31221 THERMAL DIFFUSION IN TERNARY MIXTURES. II. EXPERIMENTS. F. Van der Valk and A. E. De Vries (F.O.M. Laboratorium voor Massascheiding, Amsterdam). Physica, 29: 427-36(May 1963).

Experimental results on thermal diffusion in mixtures of two isotopes with one non-isotopic component are compared with theory. Some experimental results are: $\alpha(Ne^{22}-Ne^{20})$ in pure neon is 0.027 at 490°K, in mixtures with 100% H_2 is 0.009, and in mixtures with 100% He is 0.013; $\alpha(He^4-He^3)$ (10% He^3) in pure helium is 0.060 at 490°K, and in mixtures with 100% Ne is 0.011; $\alpha(Ar^{40}-Ar^{36})$ in pure argon is 0.014 at 440°K, and in mixtures with 100% Ne is 0.034; $\alpha(CO^{14}-CO^{12})$ in pure carbon monoxide is 0.020 at 410°K, in mixtures with 100% C_2H_4 is 0.014, in mixtures with 100% $C_2H_2D_2$ is 0.014, and in mixtures with 100% C_2H_6 is 0.011. In general, theory and experiment agree. (auth)

31222 IMPURITY EFFECTS ON He^{2+} ION YIELD IN CYCLOTRON SOURCE. N. I. Venikov and N. V. Starostin. Pribory i Tekhn. Eksperim., No. 2, 25(Mar.-Apr. 1963). (In Russian)

Impurity effects of air, argon, hydrogen, methane, and nitrogen gases on the yield of bivalent helium ions in cylotron-type sources was investigated. (tr-auth)

31223 AN APPROXIMATE CELL MODEL FOR LIQUID HYDROGEN. [PART] II. Douglas Henderson (Arizona State Univ., Flagstaff). Proc. Natl. Acad. Sci. U. S., 49: 487-92(Apr. 1963).

An approximate cell model for liquid hydrogen is examined for variation of thermodynamic properties among the H_2 isotopes. In this model the potential well of Lennard-Jones and Devonshire was approximated by a parabolic well split by a region of constant potential. The cell model used preserves the essential features of the Lennard-Jones and Devonshire theory but does not involve the computational difficulties. Data are presented on the internal entropy, quantum parameters, reduced internal energy, and reduced specific heat of the five H isotopes. Results are discussed and compared with those obtained using other calculations. (C.H.)

31224 ENERGY GAPS AND ELECTRICAL RESISTIVITY ASSOCIATED WITH SCREW-TYPE SPIN ARRANGEMENTS. Hirosi Miwa (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 29: 477-93(Apr. 1963). (In English)

Discontinuities in the energy dispersion of conduction electrons that appear in consequence of the screw-type ordering of the 4*f* spins in rare-earth metals through the *s-f* interaction are investigated theoretically. Light absorption with the electronic transition across the energy gap is discussed. The anomalous temperature dependence of electrical resistivity due to the appearance of the gaps is calculated. The result of a semi-quantitative calculation for erbium is compared with an experimental result, giving a rather good agreement. (auth)

31225 SELF-CONSISTENCY IN THE QUASI-CHEMICAL EQUILIBRIUM THEORY OF SUPERCONDUCTIVITY. Colin J. Thompson (Univ. of New South Wales, Kensington, Australia), and Takeo Matsubara. Progr. Theoret. Phys. (Kyoto), 29: 494-518(Apr. 1963). (In English)

By expressing the density matrix, for the special case of one pair state only and simple pairing, in exponential form, the results of earlier papers are reproduced and an expression for the entropy that is formally identical with that of Bardeen, Cooper, and Schrieffer and that of Bogoliubov is obtained. The expression for the entropy is shown to be exact in the limit of infinite volume. A variational calculation is then performed and the resulting set of equations is identical with that of B.C.S., thus establishing the relation between the Quasi-Chemical Equilibrium, the B.C.S., and the Bogoliubov theories of superconductivity at non-zero temperature. (auth)

31226 THE INFLUENCE OF COULOMB CORRELATION ON VARIOUS METALLIC PROPERTIES. Mitsuo Watabe (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 29: 519-27(Apr. 1963). (In English)

The Fermi liquid theory of Landau, extended by Silin to include the Coulomb interaction, is applied to investigate the effect of the Coulomb interaction on various properties of an electron gas. By assuming a simple form for the correlation function, which characterizes the correlation effect in this formalism, the corrections for specific heat (effective mass), spin paramagnetic susceptibility, Korringa relation, and the dispersion of plasma oscillation are calculated. It is shown that the effect of the Coulomb interaction on specific heat is quite small, while that on spin paramagnetism is appreciable. The effective mass of electrons on the Fermi surface is shown to be smaller than the bare mass, if the small momentum transfer processes contribute dominantly to the correlation function. (auth)

31227 MAGNETIC MOMENTS AND CRITICAL FIELDS IN SUPERCONDUCTING THIN FILMS. Kazumi Maki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 29: 603-5 (Apr. 1963). (In English)

Expressions for the change in energy gap and the current density are used to describe superconducting alloys in homogeneous magnetic fields in the limit $l/\xi_0 < 1$, where l is the mean free path and ξ_0 the correlation length of electron pairs. The magnetic moments and critical fields in thin films are derived. The Gorkov equations in a magnetic field are used in the derivation. (C.E.S.)

31228 ON SURFACE PLASMA OSCILLATIONS IN METAL FOILS. R. H. Ritchie (Oak Ridge National Lab., Tenn.). Progr. Theoret. Phys. (Kyoto), 29: 607-9(Apr. 1963). (In English)

Conditions for the surface plasma oscillations in a planar metal foil bounded on both sides by vacuum are obtained. The conditions are derived by expanding the expressions for the electron density perturbation and the scalar electric potential in Fourier integrals, neglecting externally maintained charges and fields. If collective modes in the system are to exist, the foil must be thick compared with the Debye length in the plasma. (C.E.S.)

31229 ENERGY CONVERSION BY MAGNETOHYDRODYNAMICS. F. Le Bouc (Institut Francais du Petrole, Paris), and P. Ricateau. Rev. Inst. Franc. Petrole Ann. Combust. Liquides, 18: 800-24(May 1963). (In French)

Amongst the various techniques used in converting heat into electricity, the so-called magnetohydrodynamic process seems to be promising and considerable effort is being made by various research laboratories in foreign countries as well as in France. A survey of the principal problems arising in this MHD energy conversion technique is presented, both from the theoretical and the technological points of view; a reasonable estimation is made of future prospects. (auth)

31230 DENSITIES OF STATES, SUPERCONDUCTIVITY, AND LOCALIZED MOMENTS IN TRANSITION METALS. B. R. Coles (Univ. of California, La Jolla and Imperial Coll., London). Solid State Commun., 1: 5-8(June 1963). (In English)

Correlations between density-of-states at the Fermi surface, superconductive transition temperature, and the tendency of solute iron atoms to carry localized moments are examined for second and third transition-group metals. The breakdown of expected correlations is ascribed to the change in character of the d-band wave functions. (auth)

31231 EXPERIMENTAL PROOF OF THE ABSENCE OF EQUILIBRIUM IN A HELIUM ARC. A. T. Hattenburg and H. J. Kostkowski (National Bureau of Standards, Washington, D. C.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 587-92(1962).

An atmospheric-pressure helium arc containing 6×10^{15} electrons per cubic centimeter on its axis was investigated to determine the extent of LTE (local thermodynamic equilibrium). Relative intensity measurements of a number of singlet and triplet spectral lines did not indicate the absence of equilibrium. However, the results of absolute-intensity and electron-density determinations as a function of arc radius did establish the absence of LTE. A higher-current-density arc was designed. (auth)

31232 PART A: HIGHER BORN APPROXIMATIONS FOR THE COULOMB SCATTERING OF A SPINLESS PARTICLE. PART B: THE S-MATRIX RULES IN THE EXTREME RELATIVISTIC LIMIT IN QUANTUM ELEC-

TRODYNAMICS. Ik-ju Kang. Thesis, Evanston, Ill., Northwestern Univ., 1962. 83p.

The Coulomb scattering amplitude of a Klein-Gordon particle is computed exactly to the third order in $\beta = Ze^2/\hbar v$ by perturbation theory using the potential $Ze\, e^{-\lambda r}/r$ in the limit $\lambda \to 0$. It contains only finite terms except for terms containing powers of $\ln (Q/\lambda)$ (Q^2, the squared momentum transfer), which can be shown to arise from the expansion of a common phase factor. Thus the corrections to the relativistic Rutherford cross section are obtained. These results are compared to the exact scattering amplitude in the form of the partial wave summation, expanded in powers of β, which have been summed to the third order. In conjunction with obtaining the high energy behavior of cross sections for electromagnetic processes, two Rules, and Cohelicity Conservation Law are established in the frame work of Brown's two-component fermion theory. It is shown by examples that together these results really work conveniently in simplifying involved calculations. The cohelicity conservation law may enable us also to obtain clearer physical insights, extending beyond the scope of the electromagnetic interaction. (H.M.G.)

31233 DERIVATION OF CORRECTIONS TO THE DEBYE-HUECKEL FREE ENERGY BY THE METHOD OF GAUSSIAN RANDOM FUNCTIONS. George Calvin Moore. Thesis, Evanston, Ill., Northwestern Univ., 1962. 58p.

This study was undertaken in order to verify the Yukhnovskii result for the free energy of a partially ionized gas, preferably by the use of a different mathematical method, to simplify the calculations, so that one might better understand the nature of the physical problem, and to develop the theory of Gaussian random functions as a tool for practical calculations in statistical mechanics. The starting point for the calculation is the canonical partition function for a gas of several species of particles (electrons, ions, and neutral atoms) that are assumed to interact by pair potentials only, there being both long and short range interactions. The integrand of the partition function is kept finite by including a short range repulsion between particles of opposite charge. It is shown that the partition function for this system can be represented as the average of a functional of Gaussian random functions. An exact transformation of the random functions is then made, the partition function being given as a product of two factors upon completion of the transformation. One factor yields the Debye-Hueckel term. The second factor permits an expansion in the Mayer functions, since the transformation replaces the long range Coulomb potential by the short range Debye shielded potential, and yields correction terms in the form of a modified virial series. The main result is in complete agreement with the result of Yukhnovskii. The advantage of the method of random functions is that the result is obtained by a straightforward calculation using one method only. (auth)

31234 QUANTIZATION OF THE GENERAL THEORY OF RELATIVITY. John Melton Boardman. Thesis, Syracuse, N. Y., Syracuse Univ., 1962. 378p.

It is possible to quantize most classical field theories by identifying the group of canonical transformations that maintain the covariance properties with a group of unitary transformations in Hilbert space that has the same commutator algebra. The commutators among the canonical field variables are equal to the Dirac delta function times a factor that may be zero. But in the general theory of relativity the classical group of the canonical transformations that maintain the covariance properties of the theory has an invariance subgroup. The ambiguities thus introduced by the usual process of quantization can be avoided by the use of the Dirac quantization procedure for theories with constraints. An analogy between classical Dirac brackets and commutators is established, and an intrinsic coordinate system is fixed. This choice of local intrinsic coordinate conditions leads to commutators among the canonical field variables of the general theory of relativity that depend upon the Dirac delta function and its first seven derivatives. (auth)

31235 ATOMIC CHARGE STATES OF 10- TO 40-Mev IONS OF Cl^{35}, Cl^{37} AND I^{127} EMERGING FROM CARBON-FOIL AND OXYGEN-GAS STRIPPERS. A. E. Litherland, E. Almqvist, R. H. Andrews, C. Broude, and J. A. Kuehner (National Research Council of Canada Ltd., Chalk River, Ont.). 11p. (CONF-22-12)

From American Physical Society Annual Meeting, New York, Jan. 1963.

The efficiency of oxygen-gas and carbon-foil strippers for stripping electrons from Cl and I ions at energies of 10 to 40 Mev was compared. Ions passed through a stripping chamber into a magnetic spectrometer. Results show the carbon-foil stripper to be far more effective in producing beams with high charge states. A foil thickness of 13 $\mu g/cm^2$ was found to be more than adequate for efficient stripping; the energy loss in this foil at 40 Mev turned out to be 261 kev. (D.C.W.)

31236 REVERSIBLE CHANGES OF LUMINESCENT CENTERS IN ZnS PHOSPHORS. J. Knobloch. Thesis, Munich, Technische Hochschule, 1962. 43p. $2.00.

The reversible transformation of Cu centers of blue luminescence in those with green luminescence is studied. Blue centers are produced by increasing the Cu concentration. Models for the blue and green luminescence are discussed. The activation energies for the transformation are given. (Gmelin Inst.)

31237 ABSOLUTE MEASUREMENT OF X-RAY BREMSSTRAHLUNG CROSS SECTIONS. G. Klasmeier. Thesis, Würzburg, Ger., Universität, 1962. 30p. $2.00.

The differential cross section for the production of bremsstrahlung by electrons with energies of 95 and 180 kev was measured with a scintillation spectrometer. Al_2O_3 and Au targets were used. A comparison with a theory using Born's approximation demonstrates that the Coulomb correction depends strongly on the angle even for low quantum energies. The differential cross section in regard to energy and the total cross section for radiative energy loss can be explained theoretically. (Gmelin Inst.)

31238 STUDIES OF THE POLARIZATION DEGREE IN THE SPECTRUM OF BREMSSTRAHLUNG WITH 180 kv USING THIN TARGETS. G. Zahs. Thesis, Würzburg, Ger., Universitat, 1963. 32p. $2.00.

By means of the polarization sensitivity of the Compton effect, the polarization of x-ray bremsstrahlung for Al_2O_3 and Au targets was investigated. The electron energy for these experiments was 180 kv. An emission angle of 47.7° was used. The construction of a polarimeter is described. The fraction of unpolarized radiation is decreased by a special target arrangement. Experimental results with Al_2O_3 are in agreement with theoretical predictions. For gold, discrepancies were observed. It is concluded that the theory cannot explain satisfactorily the dependence of polarization on atomic number. (Gmelin Inst.)

31239 THRUST MEASUREMENTS OF COLLOIDAL PARTICLES AS AN INDICATION OF PARTICLE SIZE

AND THRUSTOR OPERATION. Daniel S. Goldin and Carl T. Norgren (Lewis Research Center, Cleveland). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63050-63, 17p. (CONF-10-25)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Thrust measurement and its correlation to the operational characteristics of an experimental colloidal-particle thrustor are discussed. Measurements were made on a previously designed condensation colloidal-particle electrostatic thrustor with mercurous chloride as the propellant. Thrust measurements of the order of 1 to 10 milligrams were made with a modified electric microbalance calibrated to a sensitivity of 10^{-4} to 10^{-5} gram. As anticipated from the classical liquid-drop theory of nucleation, no thrust was observed until a viscous flow regime and subsequently a critical nucleation rate had been obtained in the nozzle. This condition corresponds to a vaporizer temperature of 485°K. With the assumption of singly charged colloids, it was determined that a mean particle size of 1.2×10^6 amu would be required to account for measured target deflections at a vaporizer temperature of 490°K. From an electron photomicrograph of the colloidal beam at similar operating conditions, a mean particle size of 1.7×10^6 amu was indicated. (auth)

31240 PHOTOMICROGRAPHY OF ELECTRICALLY SPRAYED HEAVY PARTICLES. C. D. Hendricks, Jr., R. S. Carson, J. J. Hogan, and J. M. Schneider (Univ. of Illinois, Urbana). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63051-63, 8p. (CONF-10-24)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The pictures indicate that charged droplet emission from high-field liquid surfaces is sporadic for some liquids. Investigations of the charge-to-mass ratio distributions for many liquids emitted from high-field points have shown that heavy, charged particles as well as ions are produced purportedly simultaneously. The sporadic phenomenon, however, tends to support the theory that heavy charged particles and ion emission do not occur simultaneously, but occur at different levels of instability of the liquid surface. (auth)

31241 CHARGING AND REMOVAL OF SURFACE-CONDENSED PARTICLES FOR COLLOID PROPULSION. Douglas M. Jambo (Hughes Research Labs., Malibu, Calif.) and Bernard Hornstein. New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63053-63, 9p. (CONF-10-26)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Work was carried out on the charging and removal of particles formed by condensing metal vapors on surfaces in vacuum. The necessary apparatus was designed and constructed for charging, accelerating, and measuring the electrical properties of charged particles having any charge to mass ratio. The apparatus is based on the measurement of the time-of-flight of charged particles, where the flight is initiated by the application of a high-voltage pulse and completed at a charge detecting device. Maximum detector sensitivity was obtained with an electron multiplier structure as the target. Tests were begun using thin film surfaces on which known particulate deposits (50 A to 500 A size range) have been grown. The objective is to determine which conditions of particle formation and of particle removal will lead to the reliable formation of a uniform particle beam within the desired Q/M range of 10^3 to 10^4 coulombs per kilogram. Initial electrical tests indicated particle removal and inferred Q/M values of 1000 to 2000 coulombs per kilogram. In only two cases, however, have electron microscope examination indicated extensive removal of the particle deposit from the substrate. (auth)

31242 SURFACE IONIZATION OF CESIUM WITH POROUS TUNGSTEN IONIZERS. R. G. Wilson, G. D. Seele, and J. F. Hon (North American Aviation, Inc., Canoga Park, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63017, 133p. (CONF-10-29)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The surface ionization properties of porous tungsten ionizers which have been sintered from powders with diameters of 0.1, 0.9, 5, 8, 12 to 18, and 44 to 74 microns and with densities from 60 to 80 percent were determined experimentally with a neutral atom and ion detector for through-fed cesium. (auth)

31243 AN EXPERIMENTAL STUDY OF COLLOIDAL PROPULSION USING SUB-MICRON SOLID PARTICLES. Stanley Singer, Nak Goo Kim, and M. Farber (Rocket Power, Inc., Pasadena). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63052-63, 3p. (CONF-10-27)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The properties of potential colloid propellant materials are considered in relation to space vehicle requirements. Some experimental difficulties encountered in the development of colloids are described. Experimental results are reported for the charging of sub-micron carbon particles by a cold-cathode ion source with an anode potential of 1000 volts. 10% of the 1-micron particles were found to have a charge of ≥ 100 coulombs/kg; this high charge can be explained by the high porosity of the particles. (D.L.C.)

31244 A SYNTHESIS METHOD OF ELECTROSTATIC GUN DESIGN. D. S. Colburn, K. J. Harker, and G. S. Kino (Stanford Univ., Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63043, 12p. (CONF-10-8)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

A method of electrostatic ion gun design is described in which the beam requirements are specified along a central trajectory. The edge trajectories and internal ion paths of a thick beam consistent with this central trajectory are then calculated. Finally, the electrodes required to form the beam are theoretically determined. While previous investigators have used this approach with the paraxial ray equation, their results are not reliable for thick beams because the paraxial ray equation gives only an estimate of the behavior of thick beams, and the error increases with the beam thickness. A straightforward extension of the paraxial method suitable for thick beams is derived which gives beam and electrode shapes to any accuracy required. Relationships were found which indicate how to specify trajectory shape and potential to meet several desirable specifications, including the following: curved trajectory, reasonably uniform emitter current density, specified accel-decel ratio, and nonintercepting exit electrodes parallel to the beam, which can provide a saddle point suitable for electron injection. A curvilinear hollow beam ion gun designed by this method is described. (auth)

Astrophysics, Cosmology, and Geophysics

31245 (D1-82-0216) MAGNETIC FIELDS IN THE OUTER SOLAR ATMOSPHERE. Ludwig Oster (Boeing Scientific Research Labs., Seattle). Mar. 1963. 89p.

On the basis of recent observations, simple mathematical models representing the magnetic field distribution in photospheric layers of the sun are proposed. The structure of the resulting fields in the outer atmosphere and, in particular, the behavior of neutral points is discussed. The expected trapping of charged particles is compared with relevant observations. Several suggestions for further experimental and theoretical studies are advanced. (auth)

31246 (NASA-TR-R-177) THE EFFECT OF A RING CURRENT ON THE BOUNDARY OF THE GEOMAGNETIC FIELD IN A STEADY SOLAR WIND. John R. Spreiter and Alberta Y. Alksne (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.). 1963. 44p.

Approximate solutions are given for the shape of the boundary separating a steady neutral stream of ionized solar corpuscles from the combined magnetic fields of a three-dimensional dipole and an equatorial ring current. Results are presented for the traces of the boundary in the geomagnetic meridian plane containing the sun-earth line for several orientations of the latter relative to the dipole axis, and for the trace of the boundary in the geomagnetic equatorial plane for the case in which the dipole axis is normal to the sun-earth line. It was found that the presence of a ring current having values for the diameter and strength of the order proposed to explain the magnetometer data from Pioneer I and Pioneer V has the effect of greatly increasing the size, as well as altering the form, of the region within which the geomagnetic field is confined. (auth)

31247 THE SOLAR-FLARE PHENOMENON AND THE THEORY OF RECONNECTION AND ANNIHILATION OF MAGNETIC FIELDS. E. N. Parker (National Center for Atmospheric Research, Boulder, Colo. and Univ. of Chicago). Astrophys. J., Suppl. Ser., 8: 177-211(July 1963).

A study is presented of the observations and theory relevant to the belief that the solar-flare phenomenon is a direct consequence of the annihilation of magnetic fields on the sun. There is very little in the observations to support such views. A systematic study of the theoretical mechanisms for diffusion, reconnection, and annihilation of magnetic fields is presented. The mechanisms discussed are Joule dissipation, ambipolar diffusion, and various forms of Sweet's mechanism. It is shown that Sweet's mechanism is much more effective in a highly compressible medium if the merging magnetic fields are exactly antiparallel. None of the known mechanisms are sufficiently rapid to account for the solar flare from the annihilation of magnetic fields. Errors and omissions in discussions of the problem are cited. Since no possible energy source other than magnetic fields is known, the question of field annihilation remains both open and pressing. The possibilities of runaway electrons and hydrodynamic instability, as means for hastening magnetic-field annihilation, are considered. It is shown that there is no reason to expect runaway electrons and no effective instability unless the fields are exactly antiparallel. (auth)

31248 THE POSITIONS AND MOVEMENTS OF THE SOURCES OF SOLAR RADIO BURSTS OF SPECTRAL TYPE II. A. A. Weiss (Commonwealth Scientific and Industrial Research Organization, Chippendale, New South Wales, Australia). Australian J. Phys., 16: 240-71 (June 1963).

The east-west position coordinates of the sources of 22 type II radio bursts, measured in the range 40–70 Mc using a swept-frequency interferometer, are analysed and discussed, in conjunction with dynamic spectra obtained in the frequency range 15–210 Mc. Many bursts are multiple and consist of a number of separate bursts excited by disturbances ejected in different directions from the vicinity of an optical flare, that may be equally complex. A statistical analysis of position data for type II and type III bursts, which reveals a remarkable similarity in the general behavior of the two types of bursts, confirms the hypothesis of generation of the radio emissions by plasma oscillations. Other topics discussed are the relative intensities of fundamental and second harmonic bands of the same burst, the relative positions of the sources of fundamental and second harmonic bands of identical frequency, and the relative position of the sources of the two ridges of a split band. Many type II bursts exhibit temporal changes of position at a single frequency. These are indicative of tangential movements in the solar atmosphere, with speeds of the order of 1000–2000 km/s. The spectra of these bursts with movement on the disk are characterized by little or no drift of frequency with time, and by broad bandwidth. A mean radial distribution of electron density in the disturbed corona is derived. This distribution does not differ greatly from that found optically for the average coronal streamer. (auth)

31249 CRITERIA FOR THE ASSOCIATION OF SOLAR FLARES WITH GEOMAGNETIC DISTURBANCES. R. W. Jenkins and Irvine Paghis (Defence Research Board, Ottawa). Can. J. Phys., 41: 1056-75(July 1963).

The statistical relation between solar flares of importance $\geq 2^+$ and the onset of geomagnetic disturbances was studied for 1949 to 1961. Disturbances were defined as an increase in $a_p \geq 50$, occurring within 12 hours or less, and these disturbances included both gradual and sudden commencement events. Associated radio noise bursts at frequencies below 300 Mc were used to select 240 major-burst flares, and the effects of flare importance, time of solar epoch, and associated polar-cap-absorption (PCA) events were considered in turn. A detailed examination was made of the effect of flare heliographic location. There was a strong positive correlation between the occurrence of major-burst flares and geomagnetic disturbances 1 to 3 days afterwards. The degree of correlation is approximately doubled when the major-burst flare was associated with a PCA event. The most probable time delay between flares and disturbances was 1.5 to 2.0 days, and this timing was relatively constant over a wide range of conditions. The dominance of northern storm-flares was confirmed. The effect was strongest for heliographic latitudes above 15°N. In addition to this effect, there was a consistent western bias of the storm-flares in both the northern and southern hemispheres, for flares associated with either gradual or sudden commencement (SC) events, with maximum concentration occurring at 10 to 15°W. Major-burst flares associated with PCA events also showed this western bias; the data suggested that there was a systematic increase in east–west asymmetry in going from major-burst storm-flares to major burst PCA flares to PCA flares accompanied by ground-level cosmic-ray increases. The corresponding longitudes of maximum concentration of the associated flares were about 10 to 15°W., 45°W., and 75°W. (auth)

31250 SYNCHROTRON RADIATION CALCULATIONS FOR THE ARTIFICIAL RADIATION BELT. M. P. Nakada (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 68: 4079-89(July 1, 1963).

Synchrotron radiation from the artificial radiation belt is calculated in some detail. The angular distribution of the electrons and of the synchrotron radiation is considered. Omnidirectional electron fluxes due to Van Allen, Frank, and O'Brien and Brown and Gabbe are used to derive directional fluxes. Temperatures as a function of frequency and of the geomagnetic latitude at 30 Mc/s are calculated. Results are compared with measurements. (auth)

31251 LUNAR AND PLANETARY INFLUENCES ON GEOMAGNETIC DISTURBANCES. E. K. Bigg (CSIRO, Sydney). J. Geophys. Res., 68: 4099-4104(July 1, 1963).

A decrease in frequency of magnetic storms at new moon, which was previously demonstrated, was further analyzed and shown to apply only to the "gradual commencement" type of storm, whereas sudden-commencement storms show an increased frequency at that time. Suggestions that Venus and Mercury influence magnetic disturbances near their inferior conjunctions with the earth are verified and extended, and it is shown that the position of the moon at these times is also important. The possibility that the "blue clearings" of Mars are related phenomena is also considered. (auth)

31252 EFFECT OF A HIGH-ALTITUDE NUCLEAR DETONATION ON THE EARTH-IONOSPHERE CAVITY. Martin Balser and Charles A. Wagner (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res., 68: 4115-18(July 1, 1963).

The spectrum of ELF radio noise around the fundamental resonant frequency (about 8 cps) of the earth-ionosphere cavity was analyzed for the period including the time of detonation of a large nuclear device in the ionosphere over Johnston Island. The peak-power frequency of the first mode was found to drop abruptly by about ½ cps at the time of the burst. The time required for recovery of the cavity from the disturbed condition appeared to be of the order of 3 or 4 hours. (auth)

31253 EARLY SYNCHROTRON RADIATION RESULTING FROM THE JULY 9 HIGH-ALTITUDE NUCLEAR DETONATION. Martin Balser and James H. Pannell (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res., 68: 4119-24(July 1, 1963).

Equipment was installed on Palmyra Island, 1450 km southeast of Johnston Island, to observe the synchrotron radiation resulting from the high-altitude nuclear detonation of July 9, 1962. Following the burst, the received noise power rose to a maximum of 15 db above the preshot cosmic noise level. Indications were that this noise was partially polarized. Observed drift times corresponded to trapped electrons with energy just under 3 Mev. It is estimated that 15 seconds after burst time perhaps a total of 10^{25} electrons were traveling along the earth's magnetic field lines. (auth)

31254 OBSERVATIONS RELATING TO THE DISTANCE SCALE FOR MOTIONS OF ELECTROJET–ELECTRON PRECIPITATION REGIONS IN THE AURORAL ZONE. D. P. Marsh (Univ. of California, Berkeley). J. Geophys. Res., 68: 4167-74(July 15, 1963).

From a comparison of x-ray, ionospheric absorption, and geomagnetic observations during an intense electron-precipitation event in the auroral zone, it is shown that the distance scale for motions of electrojet–electron precipitation regions is smaller than previously considered. This requires a downward revision of the correction factors for currents induced in the earth by ionospheric current systems. (auth)

31255 DAY-NIGHT RATIO FOR AURORAL ABSORPTION EVENTS ASSOCIATED WITH NEGATIVE MAGNETIC BAYS. R. R. Brown and J. R. Barcus (Univ. of California, Berkeley). J. Geophys. Res., 68: 4175-80(July 15, 1963).

An examination of solar illumination effects for auroral absorption events centered over the 27.6-Mc riometer antenna pattern, shows that the day-night absorption ratio is essentially unity. This finding indicates that electron-positive ion recombination far outweighs electron attachment processes in auroral absorption regions and is consistent with present knowledge of the electron bombardment as well as ionic-molecular processes at the 90- to 100-km level. Further implications of this result are discussed. (auth)

31256 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 4359-61(July 15, 1963).

Data are presented for the principal geomagnetic storm sudden commencements for the period January-March 1963. Maximum activity and ranges of the storms are presented. Solar activity characteristics are given for March 1963. (C.E.S.)

31257 THE F-REGION SEASONAL ANOMALY. J. W. Wright (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 4379-81(July 15, 1963).

It is shown that in the morning hours the ionospheric F region at low midlatitudes does not show a seasonal anomaly, and that its behavior versus the solar zenith angle is identical with that in the winter at higher latitudes. A departure from this law develops progressively with increasing latitude in the summer season. Mechanisms are presented that could reduce the summer electron content whereas it is difficult to find a sensible process that could markedly enhance the winter values. (C.E.S.)

31258 INTERPLANETARY SOLAR-WIND MEASUREMENTS BY MARINER II. Conway W. Snyder and Marcia Neugebauer (California Inst. of Tech., Pasadena, Calif.). 40p. (CONF-77-1)

From Symposium on Plasma Space Science, Washington, D. C., June 1963.

The solar plasma probe of Mariner II, consisting of a cylindrical electrostatic analyzer and a sensitive stabilized electrometer, measured the flux and energy distribution of positively charged particles moving radially outward from the Sun over a range from 230 to 8200 ev/unit charge. Approximately 40,000 such energy spectra were obtained. The plasma detected appears to consist of two components, assumed to be nuclei of hydrogen and helium. The results show that expanding solar plasma was present in space during the entire mission, with average flux in agreement with the measurements of Luniks II and III and Explorer X. The velocity is seldom constant for more than a few hours, varying between approximately 3.5 and 8.0×10^2 km/sec and showing a rather striking correlation with the daily K_p index of geomagnetic activity. This fact, together with the clear tendency for periods of high velocity to recur after 27 days, indicates that most of the plasma is emitted by localized regions on the Sun. The experimental data are summarized, and their correlation with solar events, geomagnetic events, and other interplanetary data will be discussed. (auth)

Cosmic Radiation

31259 (CONF-16-2) FLUX AND SPECTRUM MEASUREMENT OF THE COSMIC-RAY NEUTRON BACKGROUND. Progress Report. Jacob Kastner, B. G. Oltman, and L. D. Marinelli (Argonne National Lab., Ill.). [nd]. Contract [W-31-109-eng-38]. 13p.

From International Symposium on the Natural Radiation Environment, Houston, Texas, April 1963.

Design and operation of the twin scintillation spectrometer and the pulse shape discrimination circuits used to study the fast neutron background are discussed, and some preliminary results are presented and compared with those obtained at UCRL. The pulse shape discrimination circuits have proved superior to the twin system. (D.C.W.)

31260 VARIATIONS IN THE MUON FLUX CAUSED BY FORBUSH EVENTS. E. Bar-Avraham and H. Lindeman (Israel Inst. of Tech., Haifa). Bull. Res. Council Israel, Sect. F, 10: 199-211(Dec. 1962).

The effect of Forbush events on the vertical muon flux was calculated and compared with the experimental values obtained by several authors. The calculations were based on an interaction model for the transition of primaries to pions described by Shapira, and it was shown that this model leads to satisfactory agreement between the calculated and the measured muon flux at sea level. The variations in the muon flux as a result of Forbush events were calculated according to the theories given by Dorman and Morrison respectively. It appears that the experimental facts are in better agreement with Morrison's than with Dorman's theory. (auth)

31261 VARIATIONS OF THE PROTON ENERGY SPECTRUM WITH POSITION IN THE INNER VAN ALLEN BELT. J. E. Naugle and D. A. Kniffen (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 68: 4065-78(July 1, 1963).

A cylindrical stack of nuclear emulsions was flown in the payload section of a research rocket into the northern edge of the inner part of the Van Allen radiation region on September 19, 1960. The emulsion stack was shielded inside a tungsten cassette and was then exposed to the ambient radiation by rotation behind a window in the wall of the cassette covered with a 0.04-g/cm^2 aluminum shield. In this way it was possible to make a detailed study of the energy spectrum of the trapped particles at various positions in space. The rocket trajectory covered L values ranging from about 1.45 to 1.85 R_E. Five points along the trajectory were chosen for analysis, and the differential and integral proton energy spectrums were obtained for each point. Above 30 Mev in all cases, and below 30 Mev at the lower L values, the proton energy spectrums were in agreement with previous experiments; however, there was a sharp change in the slope of the spectrums with a steeper slope ($j(E) = KE^{-4.5}$) at the higher L ($L > 1.6R_E$) values than had been expected on the basis of previous experiments and the galactic cosmic ray neutron albedo theory. The data for each of the points are presented, and the results are discussed. No particles of mass greater than the proton were observed in a particle composition study averaged over the trajectory. An upper limit is presented for heavier particles in the trapped radiation. (auth)

31262 IMPULSIVE INJECTION OF ELECTRONS INTO THE EARTH'S INNER TRAPPING REGION FROM SOLAR COSMIC-RAY EVENTS. Mordehai Liwshitz and A. M. Lenchek (Univ. of Maryland, College Park). J. Geophys. Res., 68: 4091-7(July 1, 1963).

The decay of albedo neutrons generated in the polar caps by solar high-energy-particle events provides an impulsive source of geomagnetically trapped electrons. The decay density due to slow albedo neutrons (which describe ballistic orbits above the atmosphere) can be calculated from simple kinematic considerations. At constant B the injection density exhibits a peak at intermediate L. At L = 2 and B = 0.22 gauss a typical large SHEP event deposits $\sim 3 \times 10^{-6}$ electron cm^{-3}. The flux from these electrons is $\sim 10^3$ electrons cm^{-2} sec^{-1} in the interval 0-780 kev. On account of the low efficiency for detecting these electrons, it appears that this process alone cannot account for the time variations seen in Explorer 7. (auth)

31263 THE PHYSICAL SIGNIFICANCE AND APPLICATION OF L, B_0, AND R_0 TO GEOMAGNETICALLY TRAPPED PARTICLES. Edward C. Stone (Univ. of Chicago). J. Geophys. Res., 68: 4157-66(July 15, 1963).

In a dipole field, many different invariant shells (I, B_m) share exactly the same lines of force. These invariant shells are therefore members of a degenerate system. In the geomagnetic field, which is assumed static and without electric field, these degenerate systems are split by azimuthal asymmetry. A distinction is made, therefore, between the use of parameters as invariants of charged particle motion and their use as constants for all particles on a line of force. It is found that McIlwain's L value associates nondegenerate geomagnetic shells with dipole degenerate systems if L at a point in space is redefined to apply only to particles mirroring at that point. Emphasis is placed on the redefined L as an invariant parameter of particle motion and on the near equality of the L value of a particle and the equatorial radius R_0 of the line of force on which the particle is mirroring. Although the original definition of L resulted in a very useful parameter, the present definition allows a physical interpretation of L as originally applied and extends its usefulness beyond that allowed by the original definition. With the present definition, the different values of L along a line of force can be identified with the radial separation of particles mirroring on that line as they drift in longitude. This separation is ≈2 per cent of the shell radius and represents the accuracy with which a single magnetic field parameter, such as the minimum field intensity B_0 of a line, describes all particles on the line. Beyond 3 earth radii, it is found that R_0 gives a representation of comparable accuracy. However, an invariant representation (L, B_m) or (I, B_m) is limited only by the accuracy of the determination of the mirror field B_m and the longitudinal invariant I, both of which depend on the accuracy of the magnetic field representation. (auth)

31264 DAY TO DAY STUDY OF THE DIURNAL VARIATION OF COSMIC-RAY INTENSITY. M. Bercovitch (Atomic Energy of Canada, Chalk River, Ont.). J. Geophys. Res., 68: 4366-8(July 15, 1963).

Observations and analyses of cosmic-ray intensity diurnal variation were presented for periods of minimum solar activity to eliminate the disturbing and complicating effects of intense solar activity. A high counting rate neutron monitor was used. The neutron monitor data for Aug. 1962 were presented. The direction of maximum intensity was found to persist stably at an angle 90° or more to the east of the earth-sun line for times of the order of half a solar rotation period. The average direction of maximum and the corresponding average amplitude were calculated for 13½ day periods from May 1 to Dec. 31, 1962. (C.E.S.)

31265 POSSIBLE MECHANISMS OF GALACTIC X-RAY EMISSION. Satio Hayakawa and Masaru Matsuoka (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto, 29: 612-14(Apr. 1963). (In English)

Mechanisms that may give the cosmic x-ray intensity comparable to that due to synchrotron radiation are discussed. The mechanisms are based on the probable existence of low energy protons in interstellar space. These low energy protons ionize K-electrons of atoms in interstellar HI clouds and these atoms emit K x rays. The x-ray yield is obtained from the relative abundances of elements in the clouds. The slow protons can also produce knock-on electrons that in turn emit inner bremsstrahlung. (C.E.S.)

31266 THE LONGITUDINAL DISTRIBUTION OF PARTICLES IN LARGE AIR SHOWERS. R. Thielert. Thesis, Kiel, Universität, 1962. 33p. $2.00.

The average relative time delay between the electrons of large air showers at sea level was measured using 2 parallel plate counters and a short-time analyzer operating on the principle of time-to-pulse-height conversion. The average delay was 2.9 ± 0.3 nsec corresponding to an average thickness of the electron disk of 0.87 m. (Gmelin Inst.)

Criticality Studies

31267 (NAA-SR-Memo-8522) MATERIAL BUCKLING MEASUREMENTS FOR GRAPHITE MODERATED, URANIUM CARBIDE-FUELED LATTICES. E. J. Johnson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 22, 1963. Contract [AT(11-1)-Gen-8]. 29p.

Material buckling values for a series of graphite-moderated uranium carbide-fueled lattices were obtained by exponential experiment using the AE-6 thermal column as the neutron source. Three lattice pitches with center-to-center fuel spacings of 9.02, 11.015, and 12.056 in. were examined. The unit cell of the lattices was hexagonally shaped with a central control channel surrounded by 120° segments of six fuel elements located at the corners of the hexagon. The fuel consisted of 0.5-in.-diam. pins of 3 wt.% enriched uranium carbide arranged in an 18-pin cluster to mockup the element proposed for a 500 Mwe power reactor design. The fuel process tubes also contained solid sodium to mockup core coolant. The central control channel can be changed to simulate either the wet or dry control concepts. The measurements were compared with theoretical values obtained from four-group theory with fast-flux weighting and thermal pin disadvantage factors. There is considerable disagreement between the two sets of results. Critical experiments performed for the 11-in. spacing only tend to bear out the validity of the exponential measurements. (auth)

31268 (TID-19028) INTERACTION IN ARRAYS—A COMPARISON OF THEORY AND EXPERIMENT. H. K. Clark (Du Pont de Nemours (E. I.) & Co. Savannah River Lab.). [1963]. Contract [AT(07-2)-1]. 13p.

A method for computing the interaction in a critical grouping of units, each of which would be subcritical if isolated from the others, involves calculating the buckling of the unit from the albedo. Calculations were made for cylinders containing an aqueous solution of uranyl nitrate. The units were assumed to be spheres, and the cells around each unit were approximated by cubes. Both reflected and unreflected arrays were considered. For the cubic arrays, the approximation gave higher values than experiment. For planar arrays, the results obtained were conservative. The method can be applied to any interaction problem and to irregular arrays. (D.C.W.)

Elementary Particles and Radiations

Refer also to abstract 30069.

31269 (BNL-748) INTRODUCTORY LECTURES ON THE PROPERTIES, DETECTION, AND CHEMICAL EFFECTS OF HIGH ENERGY RADIATIONS. Donald J. Metz (Brookhaven National Lab., Upton, N. Y.). Sept. 1962. Contract [AT(30-2)-Gen-16]. 30p. (BNL-T-274)

Lectures on the interaction of radiation with matter, the detection and measurement of high-energy radiations, and radiation chemistry are presented. (M.C.G.)

31270 (BNL-7106) ON THE φ MESON. P. L. Connolly, E. L. Hart, et al. (Brookhaven National Lab., Upton, N. Y.); M. Goldberg, et al. (Syracuse Univ., N. Y.). [1962]. Contract [AT(30-1)-Gen-16]. 25p.

Properties of the 1020-Mev resonance (meson φ) in the K-$\overline{K}$ system were investigated by studying the reactions $K^- + p \rightarrow \Lambda + K^0 + \overline{K}^0$ and $K^- + p \rightarrow \Lambda + K^+ + K^-$ at 2.23 Bev/c. The mass, width, parity, spin, and isospin (or G) parity of the φ were determined to be M = 1019 ± 1 Mev, $\Gamma_T = 1^{+2}_{-1}$ (with $\Gamma_T > 0$), P = −1, J = 1 and I = 0 (or G = −1). The branching ratios $\varphi \rightarrow 2\pi/\varphi \rightarrow K\overline{K}$ and $\varphi \rightarrow p + \pi/\varphi \rightarrow K\overline{K}$ were measured to be < 0.2 and 0.35 ± 0.2, respectively. The vector nature of the φ is noted to distinguish it from the mass enhancement observed in the (scalar) K_1K_1 system. Details of the analysis are included. (D.C.W.)

31271 (CONF-22-1) SU_3-SYMMETRY AND THE EXISTENCE OF A NINTH VECTOR MESON. Joergen Kalckar (Carnegie Inst. of Tech., Pittsburgh). [1962]. Contract [AT(30-1)-1825]. 26p.

From American Physical Society Meeting, New York, January 1963.

Baryon-baryon and baryon-antibaryon interactions are discussed within the framework of the SU_3-symmetric octet model without assuming R-invariance. Although this model, at least in the present version, contains a free parameter in the specification of the baryon-vectormeson coupling, it turns out that the predictions of the model are not consistent with the experimental determinations of the baryon-vectormeson coupling constants, if only exchanges of members of the vectormeson octet are considered. As the simplest way of removing such discrepancy the presence is proposed of a ninth vectormeson, a unitary singlet, for which some experimental support is available. (auth)

31272 (CONF-22-6) ELASTIC SCATTERING AT HIGH ENERGIES AND REGGE PREDICTIONS. Luke C. L. Yuan (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 21p.

From American Physical Society Meeting, N. Y., Jan. 1963.

Scattering cross sections of elementary particles and their relation to the Regge pole hypothesis are discussed. Studies of p + p and π^- + p elastic scattering cross sections are described. (M.C.G.)

31273 (CONF-46-4) LEPTON ISODOUBLETS. R. L. Ingraham (New Mexico State Univ., University Park) and M. A. Melvin (Florida State Univ., Tallahassee). [1962]. Contracts AT(30-1)-1913 and AT(6-1)-2481. 15p.

From American Physical Society Meeting, Washington, D. C., Apr. 1963.

If the electron and its associated neutrino ν and the muon and its associated neutrino u are put into two isodoublets, then a strangeness-conserving isovector weak 4-current J_i

can be defined such that weak interaction $\propto J_\lambda \cdot J^\lambda$ conserves isospin. The "neutral currents" so introduced do not affect the rates of β-decay, μ-capture, etc., predict no "unwanted processes" (e.g., $\mu + p \rightarrow e + p$), and in fact predict only weak scattering. A choice between this "symmetric" theory and the present "charged current" theory may be made by looking for "Class β" scattering, such as $e + u \rightarrow e + u$, for which the present theory gives zero cross sections but the symmetric theory predicts cross sections of the same order as e-ν scattering on the present theory. (auth)

31274 (CONF-46-38) AN ACHROMATIC TRANSLATION SYSTEM FOR CHARGED PARTICLE BEAMS. D. A. Swenson (Midwestern Universities Research Assn., Madison, Wis.). [1962]. Contract [AT(11-1)-384]. 24p.

From American Physical Society Meeting, Washington, D. C., April 1963.

An assembly of bending magnets and magnetic quadrupole lenses was found which causes the axis of a beam of charged particles of momenta $p \pm \Delta p$ to be shifted from its original axis to a parallel line displaced from its original axis by a distance d. A study of this transport system demonstrated that it is possible to choose the parameters of the system in such a way that the entire system has an acceptable effect on the transverse motion of the beam, and so that the system is achromatic to first order in $\Delta p/p$. A typical transport system is given, and results are presented in graphical form for a range of parameters encompassing the typical values. (auth)

31275 (CONF-46-41) (π^--p) CHARGE EXCHANGE SCATTERING AT ZERO DEGREES. P. Borgeaud, S. Brehin, et al. (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay); and S. D. Warshaw (Argonne National Lab., Ill.). [1963]. Contract [W-31-109-eng-38]. 12p.

From American Physical Society Meeting, Washington, D. C., April, 1963.

A preliminary account is given of measurements of the cross-section $\pi^- + p \rightarrow \pi^0 + n$ in the forward direction. Both gammas from the pion decay were detected by means of a thick brass spark chamber in a "good" geometry. The chamber was triggered by a beam pion. An elaborate anticoincidence screen fitted with a Pb converter effectively prevented both charged particle events and events involving large angle gammas from triggering. The reaction took place in liquid hydrogen. A range of incident pion kinetic energies from 0.8 to 1.9 Bev was covered, with some emphasis paid to those energies for which the imaginary part of the forward cross-section vanishes, i.e., where the positive and negative pion total cross-sections are equal. The results agree qualitatively with the predictions of a dispersion relation. (auth)

31276 (JINR-E-1268) THREE-PARTICLE STATES IN THE RELATIVISTIC THEORY OF COMPLEX ANGULAR MOMENTUM. G. Domokos and P. Suranyi (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 19p.

The effects of three-particle intermediate states in relativistic field theory are investigated in some simple models. The partial wave amplitudes are meromorphic functions of the total angular momentum in some half-plane, however, the Regge-poles condense around a point, the position of which depends on the relative signs and magnitudes of the coupling constants. Correspondingly, the asymptotic behaviour of the scattering amplitudes may not be determined by a single Regge-pole. (auth)

31277 (JINR-P-1260) ISSLEDOVANIE ($\pi^+ - \pi^-$)-VZAIMODEISTVIYA PRI NIZKIKH ENERGIYAKH METODOM CHU I LOU. (Investigation of ($\pi^+ - \pi^-$) Interaction at Low Energies by Chew-Low Method). Yu. A. Batusov, S. A. Bunjatov, Do In Seb, V. M. Sidorov, and V. A. Jarba (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 12p.

The $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ reaction is analysed in the energy region 210 to 310 Mev. It is shown that for all the events the one-meson diagram is not predominant. However, the Treiman and Yang criterion does not work in this energy interval. In order to make the relative role of the one-meson diagram greater, events with small momentum transfers were selected. For these events the linear extrapolation of the experimental data was performed. In doing this, a method of conformal mapping was also used. By these two methods the mean cross section for elastic scattering $\pi^+ + \pi^- \rightarrow \pi^+ + \pi^-$ was found to be (34 ± 9) mb for a group of events with $p \leq 5$. The results of the linear extrapolation have shown that in the interval $\omega^2 = (4\text{-}7)$ the cross section for the process $\pi^+ + \pi^- \rightarrow \pi^+ + \pi^-$ is not constant and increases with ω. There are, however, indications that for events with relatively small momentum transfers the one-meson diagram is not predominant either. For this reason it is very likely that in the energy region under consideration the linear extrapolation will turn out to be insufficient. (auth)

31278 (JINR-P-1272) OSOBENNOSTI NEKOTORYKH DIAGRAMM FEINMANA. (Singularities of Some Feynman Graphs). Yi-chen Lin and J. T. Todorov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 10p.

Applications of the parametric equations obtained earlier for the proper singularities of the Feynman graphs to some scattering diagrams are treated. (auth)

31279 (NEVIS-118) ASSOCIATED PRODUCTION OF ΛK AT THE ΣK THRESHOLD. Joseph Keren (Columbia. Univ., Irvington-on-Hudson. Nevis Labs.). June 1963. Contract AT(30-1)-1932. 97p. (R-374; CU-224)

The reaction $\pi^- + p \rightarrow \Lambda^0 + K^0$ was studied in the liquid hydrogen bubble chamber at the threshold energy for the reaction $\pi^- + p \rightarrow \Sigma^0 + K^0$. The differential cross section for Λ production was found to be $d\sigma/d\Omega = 50 - 10\cos\theta - 25\cos^2\theta - 51\cos^3\theta + 56\cos^4\theta$ microbarn/steradian, with a total cross section of 0.67 ± 0.04 mb. The Λ's produced are nearly completely polarized normal to the production plane, and their decay is characterized by $|\alpha\overline{P}| = 0.60 \pm 0.05$. Two leptonic Λ decays have been identified, giving a rate for the leptonic decay consistent with one in a thousand. An unsuccessful attempt was made to detect cusp-like effects, and also to determine the $\Lambda - \Sigma$ relative parity. This attempt failed because of the presence of high angular momentum states in the $\Lambda - K$ production process. (auth)

31280 (NIRL/LN/3) UNITARY SYMMETRY. A. G. Wilson (Gt. Brit. National Inst. for Research In Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). May 1963. 20p.

A symmetry model that will produce the additional conservation laws of strangeness and baryon number conservation and that will also produce elementary particle multiplets to compress the multitude of particles and resonances now known is discussed. It is shown how symmetry principles were used to give conservation laws in quantum mechanics and quantum field theory and how higher symmetries can account for the conservation laws of high-energy physics. Multiplet schemes are suggested on the basis of various models. (M.C.G.)

31281 (ORNL-3467) A PERTURBATION METHOD FOR SOLVING THE ANGLE DEPENDENT NUCLEON-MESON CASCADE EQUATIONS. R. G. Alsmiller, Jr. and F. S. Alsmiller (Oak Ridge National Lab., Tenn.). July 30, 1963. Contract W-7405-eng-26. 35p.

A method is described for obtaining an approximate solution to the equations describing a nucleon-meson cascade by using the angular dependence of the secondary particle production kernels as a perturbation. The usefulness of the method lies in the fact that in a slab geometry the equations that must be solved numerically are essentially the same as those that are used in the straight-ahead approximation and have been solved previously. (auth)

31282 (PUC-1963-110) APPROXIMATE SINGLE-PARTICLE MOTION IN MANY-FERMION SYSTEMS (thesis). Charles B. Duke (Princeton Univ., N. J. Palmer Physical Lab.). June 1963. Contract AT(30-1)-937. 307p.

The motion of an extra-nucleon-plus-nuclear-gas system is examined by means of an initial-value problem, starting with an extra nucleon that has just penetrated the nuclear surface. Initially the system consists of a free nucleon in a dispersive medium that is in its ground state. The succeeding time behavior of the system as dictated by the non-relativistic Schrödinger equation is investigated using the single-particle Green's function. Criteria to be satisfied by the momentum-energy representation of the Green's function to permit distinction of systems with the appropriate motion are established, and a formalism for calculating the Green's functions in terms of two-body interactions between particles in the system is developed. The optical potential is defined, and the role of energy averaging in determining suitable approximations for the Green's function is discussed. The optical potential is computed using a N-N potential, and the results are compared with the results of others. 139 references. (auth)

31283 (TID-18974) COHERENT PRODUCTION AS A MEANS OF DETERMINING THE SPIN AND PARITY OF BOSONS. S. M. Berman (Stanford Univ., Calif. Stanford Linear Accelerator Center) and S. D. Drell (Stanford Univ., Calif.). [1962]. Contract [AT(04-3)-326]. 13p.

Analysis of coherent nuclear reactions to determine the parity and spin of a product boson is discussed. The case of production of a vector or axial particle by an incident pseudoscalar π or K, with its subsequent decay into two spin zero particles, is treated as an example. Decay angular distributions from bosons of spin 1, 2, 3 into bosons of spin zero and unity are listed. (D.C.W.)

31284 (TID-19072) THE KHURI-TREIMAN REPRESENTATION AND PERTURBATION THEORY. John B. Bronzan (Princeton Univ., N. J. Palmer Physical Lab.) and Claude Kacser (Columbia Univ., New York). [1963]. Contract AT(30-1)-1934. 36p.

It is characteristic of decay amplitudes that the spectral functions for their integral representations have branch points overlapping the integration contour. For the amplitude satisfying the Khuri-Treiman dispersion representation, the prescription for passing the branch points is shown to be incomplete. The full prescription is obtained using perturbation theory as a guide. It turns out that the perturbation theory prescription contradicts the dispersion theory prescription in part, even in the physical decay region of the amplitude. An interpretation is offered for this contradiction. In the perturbation analysis it is found that a non-Landau or second type singularity appears on the unphysical boundary of the physical sheet of the decay amplitude. In view of this unexpected result, the usual Landau analysis of perturbation amplitudes is extended to include examination of the singularity of the complex non-Landau surface on the physical sheet. Such an extension is valuable when an explicit formula for the spectral function is unavailable. Here the extended Landau analysis facilitates comparison of the present results with previous work on decay amplitudes. (auth)

31285 (TID-19073) ON THE ZERO-MASS LEPTONIC DECAYS OF W-BOSONS. Ngee-Pong Chang and Ching-Hung Woo (Columbia Univ., New York). [1963]. Contract AT(30-1)-1934. 25p.

The leptonic decays of the intermediate vector bosons with radiative corrections are studied in the limit where the mass of the charged lepton tends to zero. By means of a simple rule of calculation, the independence of the problem on the boson spin is shown. Thus the ratio of the decay rates $(W \to e\nu)/(W \to \mu\mu')$ is obtainable from the corresponding ratio for a spin zero boson interacting with a weak scalar current. While the radiative correction to the ratio of total decay rates is zero in this approximation, the result is also given for the nonzero correction in the case where discrimination against high bremsstrahlung photon energies is applied. The spin-independence is shown to be true for all boson spins (to the lowest order in α). (auth)

31286 (TID-19076) NOTE ON HIGH ENERGY DIFFRACTION SCATTERING. Loyal Durand, III and Kenneth R. Greider (Yale Univ., New Haven). [July 6, 1963]. Contract [AT(30-1)-1807]. 28p.

The experimental data of Foley on elastic p-p scattering were analyzed in a phenomenological manner using the impact parameter representation for the scattering amplitude in the form given by Blankenbecler and Goldberger. The detailed shape and energy dependence of the elastic differential cross section, the small ratio of the elastic scattering cross section to the total cross section, and the constant total cross section can all be explained with remarkable ease using a smooth weight function with reasonable properties. Two cases were considered. In the first, the scattering amplitude was assumed to be purely imaginary. In order to account for the observed narrowing of the elastic diffraction peak, considered as a function of the square of the invariant momentum transfer, t, it is then necessary that the radius of the interaction region increase, and its opacity decrease, with increasing energy. The necessary energy dependence cannot be determined uniquely, but is consistent with that expected on the basis of semi-classical considerations. However, some unexpected difficulties are encountered at the lower momenta, and evidence is adduced for the existence for a significant real part of the scattering amplitude for moderate values of $|t|$. The consequences of a nonzero real amplitude were investigated in a second model. It was found that the shrinking of the diffraction peak can be explained using real and imaginary amplitudes with fixed t-dependence, with the magnitude of the former decreasing relative to that of the latter with the energy dependence expected on the basis of potential-scattering considerations. It is, therefore, not possible to conclude from the observed shrinking of the diffraction peak that a Regge pole mechanism is operative, or even that the effective radius of the absorptive region is increasing, without first establishing experimentally the behavior of the real part of the scattering amplitude $t < 0$. The observation that $|\mathrm{Re}\, f(s,0)/\mathrm{Im} f(s,0)|^2 \ll 1$, as established using the optical theorem, is insufficient for this purpose. The π^--p elastic scattering data of Foley were also analyzed. (auth)

31287 (TID-19082) MULTIPION RESONANCES PRODUCED IN π^+-p COLLISIONS AT 1.95 Gev. Frederick E. James and H. L. Kraybill (Yale Univ., New Haven). [1962]. Contract [AT(30-1)-2052]. 17p.

Cross sections for the events $\pi^+ - p \rightarrow \pi^+ - p - \pi^+ - \pi^-$, $\pi^+ - p \rightarrow \pi^+ - p - \pi^+ - \pi^- - \pi^0$, and $\pi^+ - p \rightarrow \pi^+ - \pi^+ - \pi^+ - \pi^- - n$ observed in a hydrogen bubble chamber with 2.08 Bev/c mesons(π^+) were determined to be 3.64 ± 0.20, 2.75 ± 0.15, and 0.27 ± 0.04 mb, respectively. An upper limit of about 5 μb was established for the strange particle production cross section for 4-prong events. The third reaction followed the five-body phase space curves, while the first reaction was seen to go strongly through the production of the ($^1/_2$, $^3/_2$) isobar and the ρ^0 meson. The partial cross section $\pi^+ - p \rightarrow \pi^+ - p - \rho^0$ was determined to be 1.5 ± 0.2 mb. The second interaction occurred largely by production of ω^0 or η^0 mesons as well as the ($^3/_2$, $^3/_2$) isobar. The cross sections for $\pi^+ - p \rightarrow \pi^+ - p - \omega^0$ and $\pi^+ - p \rightarrow \pi^+ - p - \eta^0$ were found to be 1.6 ± 0.2 and 0.6 ± 0.2 mb, respectively. An upper limit of 17 Mev was set on the ω^0 width. A branching ratio for the $\omega^0 \rightarrow \pi^+ - \pi^-$ decay mode of 2% was obtained. Cross sections for $\pi^- - p \rightarrow 4$ prongs and resonance production are listed. (D.C.W.)

31288 (TID-19083) THE ANALYTIC STRUCTURE OF PARTIAL WAVE AMPLITUDES FOR PRODUCTION AND DECAY PROCESSES. C. Kacser (Columbia Univ., New York). July 10, 1963. Contract AT(30-1)-1934. 45p.

A model theory for studying overlapping final state interaction effects in 3-body production and decay amplitudes is considered. The model is given in terms of dispersion relations similar to those given by Khuri and Treiman for the process $K \rightarrow 3\pi$. The partial wave projections are extended into the complex plane, and their analytic properties are determined, giving explicitly a set of cuts and discontinuities. These consist of the usual right hand cut with normal discontinuity, together with a "left-hand" cut for which the discontinuity is expressed as an integral over the projections. The right hand cut can be factored out in the usual way, and thus one can hope to obtain the solution by iteration for the left hand cut contribution. (auth)

31289 (TID-19105) THE NUCLEON AXIAL-VECTOR FORM FACTOR. Ching-Hung Woo (Columbia Univ., New York). [1963]. Contract AT(30-1)-1934. 11p.

A dispersion-theoretical estimate of the rate of decrease of the nucleon axial-vector form factor with increasing momentum transfer is given. The generalized unitarity and N/D formulation appropriation for 3-particle intermediate states is used as a guide, and the ρ is treated as if it were stable. Born approximation with one-nucleon exchange is used for discontinuities across the cuts of the $<\pi - \rho/N\text{-}\overline{N}>$ amplitude. Resonance behavior in the $\pi - \rho$ scattering amplitude around S = 65 is indicated. (D.C.W.)

31290 RECENT STUDIES ON THE STRUCTURE OF ELEMENTARY PARTICLES. M. Ignat. Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn., 12: 79-93(1961). (In Rumanian)

The term elementary particles should not be taken as representing a simple homogeneous system. The concept underwent continuous changes; it was given first to atoms, then to electrons, protons, and so on. The simplified image of a small, point-like charged sphere contradicts experimentally obtained facts about electrons and does not explain satisfactorily the nature of forces which maintain the constituent parts of the system in equilibrium. Attempts were made therefore to explain the deviation in the diffusion of the point-shaped particles by a theoretical model which satisfies theory and experiment. The nucleon is assumed to consist of a center surrounded by a virtual meson cloud; the electron is considered to have a similar structure but because of its lightness, recoil phenomena become important. Dirac's theory and Rosenbluth's diffusion experiments are reviewed. Deuteron neutrons were made use of for diffusion experiments with neutrons. Born's approximation cannot be used for the central region of the nucleon because of the prevailing strong interactions, but a quasi-classical optical model was found to be acceptable especially at short wavelengths. This "intuitive" use of model requires a strong theoretical foundation which is being developed. (TTT)

31291 THE EFFECT OF THE NON-ZERO NEUTRINO REST MASS ON THE DECAY RATE OF BOUND μ-MESONS. T. Nagy (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 16: 69-72(1963). (In English)

The decay rate of mesons (μ^-) differs from that of mesons (μ^+) and for heavy elements the ratio considerably decreases. Near Z = 26 the ratio is >1. To account for the maximum and Z-dependence of the decay rate ratio, the rest mass of one of the decay neutrinos is assumed to differ from zero. The calculations are restricted to obtaining a non-zero linear term in the interaction approximation for the neutrino rest mass. It is found that this assumption fails to explain the maximum of the decay rate ratio curve near Z = 26. (C.E.S.)

31292 THE CDD POLES AND THE AGREEMENT OF A SOLUTION OF THE LOW EQUATION WITH THE EXPERIMENTAL RESULTS. Andrez Kotanski and Jozef Namyslowski (Jagellonian Univ., Krakow). Acta Phys. Polon., 23: 557-66(Mar. 1963). (In English)

The Castillejo, Dalitz, Dyson poles (CDD) that seem to be responsible for the disagreement of the Chew-Low theory of pion-proton scattering and experiments in the higher energy region are considered. After the study of possible causes of this discrepancy it is shown that a CDD pole enables one to remove the discrepancy up to 670 Mev in the case of π^+-p scattering. (auth)

31293 Ae3 DECAY AS A TEST OF V-A THEORY. L. Egardt (Uppsala Univ.). Arkiv Fysik, 24: 123-5(1963). (In English)

The $\Lambda \rightarrow p + e + \nu$ decay is discussed and it is shown that the angular correlation between the direction of the neutrino momentum in the center-of-mass system of the leptons and the direction of the proton momentum provides an immediate test of the vector-axial vector current theory for hyperons. The angular distribution of the proton about the direction of Λ-polarization that gives information about the magnitudes of the form factors in the case of current-current coupling is also discussed. (C.E.S.)

31294 EVIDENCE FOR A Σ HYPERON-PION RESONANCE AT 1404 Mev WITH NARROW WIDTH. A. Frisk (Univ. of Stockholm). Arkiv Fysik, 24: 221-44(1963). (In English)

Evidence for a Σπ resonance at 1405 Mev but with a width much narrower than 50 Mev is presented. A study was made of 1427 2-prong stars due to K^- capture by nuclei in emulsion. A sample of 192 events with a charged Σ hyperon and a pion were analyzed in detail. The discovery of an unexpectedly sharp line in the momentum distribution of the Σπ system is reported. This line, which lies in the momentum interval 160–180 Mev/c, is found to be strongly correlated with events having a recoil track due to the residual nucleus. By careful study of recoil

ranges and invariant mass values it is found that the reaction most probably responsible for the line is $K^- + C^{12} \rightarrow Y^* + B^{11}$, where Y^* is a resonant state in the $\Sigma\pi$ system. From the position of the line, 172 ± 2 Mev/c, and its spread consistent with the experimental resolution, ±5 Mev/c, the mass 1404.2 ± 0.4 Mev and the full width $\Gamma \leq 1.4$ Mev are obtained. (auth)

31295 ON THE ACCURACY OF THE TAN ηl DISTORTED WAVE APPROXIMATION FOR SCATTERING PHASE-SHIFTS. P. Swan (Univ. of Melbourne). Australian J. Phys., 16: 177-84(June 1963).

The distorted wave approximation for tan ηl involves a wave function distorted from its asymptotic form at $r \rightarrow \infty$ by a form factor $g_l(r)$. Schwinger's variational principle is adapted to show that increasing the number of variable parameters in $g_l(r)$ does not necessarily improve the first-order fit to the scattering parameters. Results are given for ^3S and ^1S neutron-proton scattering for several potential well shapes, including the effective range r_0 and first shape parameter P_0. It is concluded that the distorted wave method gives maximum accuracy with a simple form factor with only one variable parameter λ_l, adjusted to fit the zero-energy scattering length α_l. The use of additional parameters is not in general justified by the results. (auth)

31296 LORENTZ-COVARIANT ANALYTIC FUNCTIONS. Klaus Hepp (Eidgenössische Technische Hochschule, Zurich). Helv. Phys. Acta, 36: 355-75(1963). (In German)

The structure of the module $O_{[r,s]}(D)$ of holomorphic tensor fields (transforming according to the irreducible representation [r,s] of the proper complex Lorentz group $L_+(C)$) over the ring $O_{[0,0]}(D)$ of $L_+(C)$-invariant holomorphic functions is investigated. A decomposition of every $F \in O_{[r,s]}(D)$ into a finite linear combination of tensor polynomials $Q_\kappa^{[r,s]} \in O_{[r,s]}(D)$ with $L_+(C)$-invariant holomorphic coefficient functions is shown to exist (locally) for a large class of domains D. It is proved that in such domains each $L_{(+)}(C)$-invariant holomorphic function is a strongly holomorphic function of the $L_{(+)}(C)$-invariants. The results are applied to the Wightman functions of arbitrary spinor fields, for which for instance it is shown that all 3-point functions can be continued into the Källén-Wightman domain. Sufficient conditions for the existence of invariant amplitudes for scattering and production processes are given. (auth)

31297 INTERACTIONS OF 0.2- TO 1.3-Bev MUONS WITH ELECTRONS. A. Heym. Helv. Phys. Acta, 36: 376-88(1963). (In French)

A coincidence and anticoincidence Geiger-Müller hodoscope with 1 μsec resolution time selects 1615 ± 35 Mev mean-energy cosmic μ mesons, by stopping them in 112.5 ± 2.5 cm Pb. From a run of 10,200 registered tracks, the number of secondary electrons of energy greater than 1 Mev is measured, in equilibrium with the μ radiation at five levels of the apparatus. The experimental results are compared with those of a calculation starting from the cross sections and the $e^\pm-\gamma$ shower theory. At the μ mean energy of 1315 ± 35, 1015 ± 35, 725 ± 35, 450 ± 35, and 255 ± 35 Mev respectively, the experimental probabilities are respectively 9.5, 9, 7.3, 7, and 3.8%, and the expected probabilities 11.27, 9.97, 8.24, 6.5, and 4.38%. (auth)

31298 PROPAGATOR GHOSTS AND REGGE POLES. H. M. Fried (New York Univ., New York) and J. G. Taylor. J. Math. Phys. (N. Y.), 4: 727-30(June 1963).

In the approximation of considering only vertex contributions to the propagator, sufficient conditions on the two-particle scattering amplitude that does not generate ghosts in the propagator are determined. The Regge type of behavior does not satisfy these conditions, and gives rise to ghosts unless cancellations occur coming from the higher inelastic contributions to the vertex-function unitarity condition, which were neglected in the calculation. The double-pole behavior discussed by Frye is found to be the only two-particle scattering-amplitude behavior that has no propagator ghosts, under certain general conditions. (auth)

31299 THEOREM ON ENERGY SHIFTS DUE TO A POTENTIAL IN A LARGE BOX. Fumiaki Iwamoto (Brandeis Univ., Waltham, Mass.). J. Math. Phys. (N. Y.), 4: 809-11(June 1963).

A theorem conjectured by Cohen, which gives a concise form to the Rayleigh–Schrödinger perturbation series for energy shifts due to a potential in a large box, is proved. (auth)

31300 GENERALIZED DIELECTRIC FUNCTION FOR CLASSICAL MANY-BODY SYSTEM. Amiram Ron (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 4: 811-23(June 1963).

A dielectric function is introduced for classical systems of many interacting particles in terms of the N-particle distribution function in phase space. The system is considered as a whole using the Liouville equation instead of the canonical equations or the B-B-G-K-Y hierarchy. To facilitate the calculation, the diagrammatic technique of Prigogine and Balescu is introduced in terms of which a systematic asymptotic analysis is carried out for two simple cases: (1) a system of weak interaction and (2) a simple model of plasma. The treatment is restricted to systems in thermal equilibrium. (auth)

31301 ZEROS OF HANKEL FUNCTIONS AND POLES OF SCATTERING AMPLITUDES. Joseph B. Keller, S. I. Rubinow, and Max Goldstein (New York Univ., New York). J. Math. Phys. (N. Y.), 4: 829-32(June 1963).

The complex zeros $\nu_n(z)$, n = 1, 2, ⋯ of $H_\nu^{(1)}(z)$, $dH_\nu^{(1)}(z)/dz$ and $dH_\nu^{(1)}(z)/dz + iZH_\nu^{(1)}(z)$ are investigated. These zeros determine the poles in the scattering amplitudes resulting from scattering of various kinds of waves by spheres and cylinders. Formulas for $\nu_n(z)$ are obtained for both large and small values of |z| and for large values of n. In addition, for $H_\nu^{(1)}(z)$ and $dH_\nu^{(1)}(z)/dz$, numerical solutions are found for real z in the interval $0.01 \leq z \leq 7$ and n = 1, 2, 3, 4, 5. The resulting loci of $\nu_n(z)$ in the complex ν plane are presented. These loci are the trajectories of the so-called Regge poles for scattering by spheres and cylinders. (auth)

31302 MORE INTEGRAL REPRESENTATIONS FOR SCATTERING AMPLITUDES WITH COMPLEX SINGULARITIES. C. Fronsdal, R. E. Norton, and K. T. Mahanthappa (Univ. of California, Los Angeles). J. Math. Phys. (N. Y.), 4: 859-71(July 1963).

Previous work is generalized in order to achieve a better understanding of the role of complex singularities in connection with integral representations. The most general conditions under which the box-diagram contribution to a scattering amplitude satisfies a representation with real integration contours are derived. Explicit representations are derived in several special cases. It is frequently found possible to obtain representations that are essentially of the Mandelstam type, although the more general Bergman-Oka–Weil representation must be invoked in general. One example of a three-dimensional representation is given, which exhibits the analytic structure in one of the external

masses in addition to the kinematical variables. The significance of the "physical sheet" is discussed. (auth)

31303 ACNODES AND CUSPS AND THE MANDELSTAM REPRESENTATION. Jamal N. Islam (Cambridge Univ., Eng.). J. Math. Phys., (N. Y.), 4: 872-8(July 1963).

Complex singularities on the physical sheet associated with acnodes (isolated real points) and cusps are found for a particular Feynman diagram. These singularities emerge before the appearance of anomalous thresholds, and cause a breakdown of the Mandelstam representation. (auth)

31304 PARTICLE CHARGE SYMMETRIES AS R_8 SUBGROUPS. D. C. Peaslee (Australian National Univ., Canberra). J. Math. Phys. (N. Y.), 4: 910-14(July 1963).

It is shown how the formalism of 8 × 8 Dirac matrices can be extended to include all the groups so far proposed as relevant to elementary-particle charge symmetries: R_4, R_7, G_2, SU_3. These are all treated as subgroups of R_8, which appears to determine the eightfold structure of the particle families, even before the particle interactions are "switched on." Since these subgroups of R_8 are incompatible, they will lead to a "clash of symmetries," as observed experimentally. It is pointed out that if the plausible association is made between real and charge-space statistics in representations of R_8, the group SU_3 satisfies charge conjugation invariance for 3-boson interactions but not for two-fermion–one-boson interactions. An argument is given that the representations 8 and $\bar{8}$ of SU_3 plus the representations (7 + 1) of G_2 and R_7 completely span the symmetries obeying the limited invariance implied by conservation of isotopic spin I and hypercharge Y. (auth)

31305 A CONTRIBUTION TO THE STUDY OF ANTIPROTON ANNIHILATIONS IN NUCLEAR EMULSIONS. I. Ahmad, J. Aslam, and A. Hossain (Atomic Energy Centre, Lahore). J. Nat. Sci. Math., 3: 1-5(Apr. 1963).

A systematic analysis of different types of prongs of stars induced by antiproton annihilations at rest yields quantitative information concerning mean multiplicities and mean kinetic energies of pions emitted in annihilations of antiprotons with nucleons of light as well as heavy nuclei present in nuclear emulsion. (auth)

31306 SOME REMARKS ON THE PRESENT STATUS OF THE THEORY OF ELEMENTARY PARTICLES. Michael J. Moravcsik (Atomic Energy Centre, Lahore). J. Nat. Sci. Math., 3: 20-6(Apr. 1963).

Attempts to develop a general theory of elementary particles on the basis of field theory, s-matrix theory, the complex angular momentum formalism, and group theoretical methods are reviewed. Failures of these efforts are discussed. (D.C.W.)

31307 CONCERNING THE PRECISE DETERMINATION OF GAMMA ABSORPTION COEFFICIENTS. R. Quivy (Centre de la Faculté Polytechnique, Mons, Belg.). J. Phys. 24: 169-72(Mar. 1963). (In French)

A method is proposed for the determination of the gamma absorption coefficient, with a precision of a few tenths of a percent. Different possible interpretations of the response of a group scintillator-analyzer are discussed. The maximum counting rate is experimentally limited by the deformation of the photoelectric peak. (auth)

31308 ON A POSSIBILITY OF MUON-ELECTRON COMPARISON AT VERY HIGH ENERGY. Paul Kessler (Collège de France, Paris). J. Phys., 24: 222-4(Mar. 1963). (In French)

An experiment is proposed in which a photon (Bev range) strikes a thin H_2 target, and the recoil proton is detected in triple coincidence with the $e^{\pm}$ or $\mu^{\pm}$ pair that is also produced. The lepton pair is assumed to be emitted nearly collinearly. Theory predicts that under given kinematic conditions, the same number of electron and muon pairs should be produced, independent of momentum transfer, if the momentum transfer is much greater than 100 Mev. Significant deviations from this predicted behavior should indicate either a vertex anomaly, such as a non-electromagnetic muon-proton interaction or an anomalous muon form factor; or a propagator anomaly. (T.F.H.)

31309 GAMMA-FLUX DETERMINATION WITHIN EXTENDED SOURCES. F. W. Krueger and A. Mueller (VEB EPkA, Berlin). Kernenergie, 6: 207-9(May 1963). (In German)

One well-known method from the neutron transport theory was used in order to determine the gamma flux in all points in the interior of a homogeneous region G at certain distances from this boundary. An upper limit for the relative error for the use of this method for flux determination at places in the neighborhood of the boundary of G can be easily estimated. Especially simple were the proportions, when, as for the gamma source in a fission zone, the specific source strength complies with a wave equation. (tr-auth)

31310 A VARIATIONAL METHOD FOR NON-LINEAR SPINOR THEORY. Katsuhiko Sekine (Max-Planck-Institut für Physik und Astrophysik, Munich). Nucl. Phys., 44: 195-204(June 1963). (In English)

The generalized free field of Greenberg and Dell'Antonio is extended to the case when the Hilbert space has an indefinite metric, and is used as a trial function for calculating the ground state in the non-linear spinor theory of Heisenberg. The condition for the non-canonical quantization is derived as a consequence of the variational principle. (auth)

31311 THE η-MESON AND SCALAR BOSON CONTRIBUTIONS TO THE PHOTON-PROTON ELASTIC SCATTERING. S. K. Kundu and M. Yonezawa (Australian National Univ., Canberra). Nucl. Phys., 44: 499-506 (July 1963). (In English)

The effect of the η meson and a scalar boson on photon-proton scattering is discussed. It is shown that the contribution of these bosons tends to explain some of the discrepancies observed in the analysis of this scattering, if the signs of the amplitudes of the η meson and scalar boson are chosen appropriately. A rough estimate is made of the limits for the coupling constants, which are the products of the boson-nucleon and boson-photon coupling constants. (auth)

31312 THEORY OF MESONS, BARYONS, AND RESONANCES. Robert L. Anderson and Suraj N. Gupta (Wayne State Univ., Detroit). Nucl. Phys., 44: 507-17(July 1963). (In English)

A theory of mesons, baryons, and resonances is developed in the three-dimensional isospace by assuming that the resonances should be expected to satisfy the same symmetry requirements as the elementary mesons and baryons. It is also assumed that the effective Lagrangian density for strong interactions should be invariant not only for arbitrary rotations of the axes in the isospace but also for simultaneous rotations of the axes in their complex planes. Besides the usual eight mesons and eight baryons, the formalism predicts the existence of additional particles and resonances with higher hypercharges and charges. In particular, the theory is able to account

for the singly charged particles with anomalous hypercharges observed in cosmic ray stars, and many of the resonances observed in meson-baryon interactions. (auth)

31313 THE STABILITY OF HARTREE-FOCK SOLUTIONS AND OF COLLECTIVE MOTION. Nobuyuki Fukuda (Inst. of Mathematical Sciences, Madras). Nucl. Phys., 44: 553-71(July 1963). (In English)

It is proved that the stability of the Hartree-Fock ground state against any small deformation, preserving the single particle nature of the wave function, ensures the stability of collective motions in the random phase approximation and vice versa. Therefore, if a collective motion has a finite life time, the HF ground state is necessarily unstable against the deformation generated by the corresponding collective mode. As an illustration, an infinite system of particles interacting by means of a δ-function potential is considered and it is shown that the stability condition for the HF ground state is in fact identical to that for the collective motion. (auth)

31314 NOTE ON THE PHASE SHIFTS FOR THE SCHRÖDINGER AND DIRAC EQUATIONS. T. Tietz (Univ. of Lodz, Poland). Nucl. Phys., 44: 633-6(July 1963). (In English)

Relations between the scattering phase shifts for the radial equations derived from the Schrödinger and Dirac equations are established. A new method for finding approximate scattering phase shifts is presented. A comparison is made between numerical results for long-tailed potential obtained by exact numerical and this method. (auth)

31315 ELASTIC SCATTERING AND POLARIZATION IN 3.0 AND 3.6 Gev/c ANTIPROTON-PROTON COLLISIONS. B. Escoubès, A. Fedrighini, Y. Goldschmidt-Clermont, et al. (CERN, Geneva). Phys. Letters, 5: 132-6 (June 15, 1963). (In English)

A total of 1752 elastic events obtained in photographs from the Saclay 81-cm hydrogen bubble chamber was analyzed. The results are compared with those on p-p scattering, and are discussed in terms of the optical and Regge pole models. The diffraction peak is much narrower than in p-p scattering, while the cross section at large angles is significantly less than for p-p scattering. The extrapolated forward cross section is compared with the value deduced from the total cross section by the optical theorem. The polarization value obtained ($P^2 = 0.214 \pm 0.13$) compares with the values $P = 0.5^{+0.09}_{-0.13}$ for events at 1.61 and 2 Bev and $P = 0.30 \pm 0.09$ for p-p scattering at 1.7 Bev. (D.C.W.)

31316 THE FIELD THEORETICAL λ-λ POTENTIAL. A. Deloff (Inst. for Nuclear Research, Warsaw). Phys. Letters, 5: 147-8(June 15, 1963). (In English)

The Λ-Λ potential is derived from a charge independent hamiltonian using the procedure of De Swart and Iddings. For even Λ-Σ parity, the potential is simply related to the fourth order N-N potential. For odd Λ-Σ parity the Λ-Λ potential shows a formal resemblance to the N-N potential in scalar theory with scalar coupling. An expression for the binding energy of the two Λ is derived; this quantity is concluded to be positive. (D.C.W.)

31317 POLARIZATION OF VECTOR BOSONS PRODUCED BY NEUTRINOS. J. S. Bell and M. Veltman (CERN, Geneva). Phys. Letters, 5: 151-2(June 15, 1963). (In English)

Calculations reveal that hypothetical intermediate bosons produced by neutrinos incident on the Coulomb fields of nucleons and nuclei are strongly circularly polarized in the same sense as the incident neutrinos. Muons from the decay of fast bosons are noted to be slower and to have more angular spread than in the absence of this polarization. (D.C.W.)

31318 FURTHER EVIDENCE FOR THE f^0-MESON AND A DETERMINATION OF ITS SPIN. L. Bondàr, K. Bongartz, M. Deutschmann, et al. (Technische Hochschule, Aachen). Phys. Letters, 5: 153-6(June 15, 1963). (In English)

Dalitz plots for the reaction $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ and $\pi^- + p \rightarrow p + \pi^- + \pi^0$ were obtained as well as effective mass distributions for the $\pi^- - \pi^+$ and $\pi^- - \pi^0$ systems resulting from the reactions. In the $\pi^+ - \pi^-$ distribution a peak at a mass corresponding to f^0 was observed. Additional evidence for the f^0 was obtained from the Dalitz plots and from the forward-backward asymmetry of the $\pi^- - \pi^-$ scattering angle distribution. Consideration of the $\pi - \pi$ scattering cross section and angle distribution indicated spin two for this resonance. A central mass value of 1260 Mev and a full width at half height of 160 Mev were also found for the f^0-meson. (D.C.W.)

31319 DIFFRACTION SHRINKING AND REGGE TRAJECTORIES. R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 5: 159-61(June 15, 1963). (In English)

The possibility of two Regge poles, rather than one, dominating scattering even at energies of 30 Bev is considered. It is noted that two Regge poles may simulate one and that this apparent trajectory may lie far from the true leading trajectory. It is also observed that the diffraction pattern can shrink over a finite energy range even when neither trajectory has a slope for $\ln (d\sigma/dt)$ vs $\ln E_L$, where $d\sigma/dt$ is the differential cross section and E_L is the bombarding energy. (D.C.W.)

31320 DETERMINATION OF THE γ-π-ρ COUPLING CONSTANT FROM THE −/+ RATIO FOR PHOTOPRODUCTION FROM DEUTERIUM. J. Pine and M. Bazin (Stanford Univ., Calif.). Phys. Letters, 5: 168-70(June 15, 1963). (In English)

Gamma rays from a Ta radiator were allowed to fall on a liquid D target. The pions emitted were selected by a magnet spectrometer and were detected with a counter telescope. The ratio of π^-/π^+ produced was determined, and corrections were made for p-p and π-p coulomb interactions in the final state and for the n-p mass difference. This gave the ratio of the cross sections $\gamma + n \rightarrow \pi^- + p$ and $\gamma + p \rightarrow \pi^+ + n$ from which Λ, the γ-π-ρ coupling constant, was estimated to be 0.1 ± 0.3. (D.C.W.)

31321 COMPLETE CLASSIFICATION OF STATES OF SUPERMULTIPLET THEORY. M. Moshinsky and J. G. Nagel (Universidad de Mexico, Mexico City). Phys. Letters, 5: 173-4(June 15, 1963). (In English)

The rows of the bases for the irreducible representations of the group SU_4 in which the subgroup $SU_2 \times SU_2$ is explicitly reduced are determined. Starting from the commuting annihilation and creation operators denoting spin-isospin states that satisfy the necessary commutation relations, the commuting operators needed to characterize the rows are derived. (D.C.W.)

31322 BINDING ENERGY OF THE ALPHA PARTICLE AND THE VELOCITY-DEPENDENT POTENTIALS. J. Borysowicz and M. Zielińska (Inst. for Nuclear Research, Warsaw). Phys. Letters, 5: 175-6(June 15, 1963). (In English)

The binding energy of the alpha particle was calculated by a variational method using the velocity-dependent poten-

tials derived by Green as well as the Herndon potential. The calculated binding energies are small in comparison with experimental values. The results show the importance of short range correlations between pairs of nucleons and the sensitivity of the binding energy to changes in the relative strength of central and tensor forces. (D.C.W.)

31323 SEARCH FOR TIME-LIKE STRUCTURE OF THE PROTON. M. Conversi, T. Massam, Th. Muller, and A. Zichichi (CERN, Geneva). Phys. Letters, 5: 195-8 (July 1, 1963). (In English)

An attempt was made to observe the process $\bar{p} + p \rightarrow e^- + e^+$, the rate of which depends on the unknown time-like form factors. The equipment and procedure followed in the experiment with a 2.5 Bev/c $\bar{p}$ beam is described. The cross section at this energy for a point-like proton is estimated to be about 0.25 μb. No events, however, were observed; and only an upper limit of 2×10^{-32} cm^2/ster was determined for the point-like differential cross section, thereby giving evidence against a point-like proton in the time-like region. Evidence for an electromagnetic structure of the proton in the time-like region is also noted. (D.C.W.)

31324 ON THE ANGULAR DISTRIBUTION OF THE BROOKHAVEN 1962 NEUTRINO EXPERIMENT. J. Loevseth (CERN, Geneva). Phys. Letters, 5: 199-201(July 1, 1963). (In English)

The differential cross section calculated by a Monte-Carlo method and by averaging over the appropriate neutrino spectrum for the experiment gives the general shape of the observed angular distribution. This shows the compatibility of the angular distribution with current weak interaction theory. Calculated distributions from π and K neutrinos show fewer events in the forward direction than observed, indicating that the K neutrino intensity was underestimated. (D.C.W.)

31325 EXTENSION OF A REDUCTION FORMULA FOR THE VERTEX FUNCTION. S. Klarsfeld (Institut Henri (Poincaré, Paris). Phys. Letters, 5: 204-5(July 1, 1963). (In English)

Halpern's formula for the five-point function, an extension itself of Kallen and Wightman's result on the vertex function, is extended to any n-point function with n an odd integer. It is also shown that the special form of the integration region in α-space (a hypercube) makes it unnecessary to invoke the generalized Stokes' theorem. (D.C.W.)

31326 ON THE D-WAVE CONTRIBUTION IN THE n-He^4 ELASTIC SCATTERING AT 15 Mev. R. Malaroda (Università, Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Trieste, Italy), G. Poiani, and G. Pisent. Phys. Letters, 5: 205-7(July 1, 1963). (In English)

The D-wave contribution that complicates phase shift analysis of n-He^4 scattering at energies greater than 10 Mev was examined. 14.9-Mev neutrons were elastically scattered; the cross section was determined; and from coefficients involved in the cross section S, P, and D phase shifts were calculated. Cross sections and polarizations were calculated from the phase shifts. The S and P phase shifts agree with literature values, but the evidence for D phase shifts ≥ 0 contradicts some other results. (D.C.W.)

31327 EXPERIMENTAL RESULTS ON THE CROSS SECTION FOR $\pi^-\pi^0 \rightarrow \pi^-\omega^0$. L. Bondàr (Technische Hochschule, Aachen), E. Keppel, G. Kraus, et al. Phys. Letters, 5: 209-11(July 1, 1963). (In English)

The cross section was determined by the Chew-Low method from $\pi^- - p \rightarrow \pi^- + p + \omega^0$ interactions observed in a hydrogen bubble chamber. One pion exchange is taken to dominate the π^--p event. Cross sections for a variety of values of W^2 (total π^--ω^0 energy squared) and Δ^2 (four-momentum transfer for one pion exchange squared) are given. A maximum is observed at $W^2 = 1.6$ Bev^2, in agreement with Xuong. The ω-decay width is concluded to be between 3 and 11 Mev. (D.C.W.)

31328 RESONANT STATES IN THE MESON-BARYON SYSTEM. S. Minami and K. Mori (Louisiana State Univ., Baton Rouge). Phys. Letters, 5: 220-2(July 1, 1963). (In English)

The relation $J - L = I - 1$ proposed by Kycia and Riley for the resonant states in the π-N system is generalized to obtain the selection rule $J - L = I - \frac{1}{2} - |Y| + |Y|^2/4\,[1 - |s| \cdot |Y|]$ for resonant states in the meson-baryon systems. Here, I and J are the isotopic spin and spin of the state; L is the relative angular momentum; and S and Y = N + S are the strangeness and hypercharge of the system. This relation shows that: there is no resonant state in the K-N system; in the π-Σ system, there is no resonant state with I = 2; and in the π- Ξ system, there is no resonant state with $I = \frac{3}{2}$. Description of the Y*'s and the basic particle in the π- Ξ system is discussed. (D.C.W.)

31329 ON QUANTUM ELECTRODYNAMICS WITH A REGGIZED PHOTON. D. V. Volkov (Universitet, Copenhagen) and A. F. Bakai. Phys. Letters, 5: 223-4(July 1, 1963). (In English)

A representation of the contribution of the photon Regge pole to the scattering amplitudes that is completely factorized and, therefore, contains the same number of electromagnetic form factors as the conventional theory is presented. Expressions for the electron scattering cross sections in the s-channel are derived; the e-e scattering cross section is specifically given. Modifications necessary to obtain the formulas in the t-channel are described. (D.C.W.)

31330 THREE-BODY PROBLEM WITH SEPARABLE POTENTIALS. II. n-d SCATTERING. A. N. Mitra (Indiana Univ., Bloomington) and V. S. Bhasin. Phys. Rev., 131: 1265-71(Aug. 1, 1963).

The three-body formalism, using separable potentials in s and p states of nucleon pairs, is set up under the conditions of full antisymmetrization of the three-nucleon wave function. The formalism is applied to the problem of n-d scattering, where the effects of "polarization" are fully taken into account. The amplitudes for quartet and doublet scattering are found to satisfy two- and four-coupled one-dimensional integral equations, respectively. The quartet scattering length is found to agree with the figure for the so-called experimental set I for this parameter. The doublet scattering length, on the other hand, is found to be much more sensitive to the details of the potentials, thus preventing a theoretical resolution of its ambiguity within the present formalism without tensor forces. (auth)

31331 ELECTROMAGNETIC CORRECTION EFFECTS ON THE $\pi^+ \rightarrow \pi^0 e^+ \nu$ DECAY. Ngee-Pong Chang (Columbia Univ., New York). Phys. Rev., 131: 1272-5(Aug. 1, 1963).

Recently experiments have been done on the rare decay of the π^+ into the $\pi^0 e^+ \nu$ mode as a third and independent test of the conserved vector current hypothesis. This note reports briefly on a simple perturbation calculation of the radiative corrections. With a cutoff of around a nuclear mass, the radiative correction shortens the lifetime by $\sim -1.1\%$. (auth)

31332 INTERACTIONS OF 1.61-Bev/c ANTIPROTONS IN HYDROGEN INVOLVING TWO OUTGOING CHARGED PARTICLES. Gerald R. Lynch, Robert E. Foulks, George R. Kalbfleisch, Sylvia Limentani, Janice B. Shafer, M. Lynn Stevenson, and Nguyen-huu Xuong (Univ. of California, Berkeley). Phys. Rev., 131: 1276-86(Aug. 1, 1963). (UCRL-10632)

Interactions of 1.61-Bev/c antiprotons in hydrogen yielding two charged particles have been studied, with particular attention to elastic scattering, single-pion production, and annihilation into three or more pions. Effects of misinterpretation of events are estimated by Monte Carlo calculations. Nine partial cross sections have been measured. The elastic-scattering data show a secondary diffraction peak at about 82° in the center-of-mass system. Single pion production is found to be consistent with charge-conjugation invariance. In the single pion events ($\bar{p} + p \rightarrow \bar{N} + N + \pi$) the predominance of low-momentum transfer exceeds that predicted by the single pion exchange formula of Chew and Low. No two-pion resonances have been observed anywhere in the data. (auth)

31333 TWO-MESON ANNIHILATIONS OF 1.61-Bev/c ANTIPROTONS IN HYDROGEN. Gerald R. Lynch, Philippe Eberhard, George R. Kalbfleisch, Joseph E. Lannutti, Bogdan C. Maglić, Janice B. Shafer, M. Lynn Stevenson, and Nguyen-huu Xuong (Univ. of California, Berkeley). Phys. Rev., 131: 1287-9(Aug. 1, 1963). (UCRL-10633)

Proton-antiproton annihilations at 1.61 Bev/c with only two mesons in the final state have been examined in the 72-in. bubble chamber. The partial cross sections measured are: $\bar{p} + p \rightarrow \pi^- + \pi^+$, 119 ± 30 μb; $\bar{p} + p \rightarrow K^- + K^+$, 55 ± 18 μb. The K^- distribution in $\bar{p} + p \rightarrow K^- + K^+$ is peaked strongly forward, with 7 of the 11 K^- mesons produced in the forwardmost tenth of the total solid angle. The π^- events show no such effect, with only 2 of the 22 π^- mesons being produced in the same forward interval. Careful study of possible contamination of these events indicates that almost all of them are genuine two-meson annihilations. (auth)

31334 PION-NUCLEON SCATTERING IN THE BOUNDARY-CONDITION MODEL. I. INELASTIC EFFECTS ON S WAVES. H. Goldberg and E. L. Lomon (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 131: 1290-1302(Aug. 1, 1963). (TID-18902)

S-wave amplitudes for both $T = \frac{1}{2}$ and $T = \frac{3}{2}$ π-N scattering in the 0–500 Mev range are constructed by means of the boundary-condition model. Included in the Hermitian F matrix is a production channel in which the two outgoing pions are assumed strongly correlated in the $T = 0$, $J = 0^+$ state. The behavior of the amplitude so derived is in agreement with the present analyses of the experimental data, and shows in a simple manner the mechanism for obtaining a maximum in the cross section through the introduction of an inelastic channel. (auth)

31335 MODIFIED K* EXCHANGE MODEL FOR ΛK^0 PRODUCTION. G. T. Hoff (Univ. of Chicago). Phys. Rev., 131: 1302-7(Aug. 1, 1963).

A model is proposed to explain simultaneously the backward peaking of the Λ particles in the reaction $\pi^- + p \rightarrow \Lambda + K^0$, the large polarization observed, and the peak of the total cross section. The K* exchange diagram and a resonant state in our channel are considered as the main contributions to the amplitudes. By assuming a resonant $p_{\frac{1}{2}}$ state, excellent fits to the angular distribution and polarization are obtained at a pion kinetic energy of 871 Mev and at an incident pion momentum of 1.01–1.05 Bev/c. A fairly good fit is obtained at a pion kinetic energy of 791 Mev. A new estimate for the $K^*\Lambda N$ coupling constant is given. (auth)

31336 DYNAMICAL MODEL OF THE K* RESONANCE. Richard H. Capps (Università, Rome). Phys. Rev., 131: 1307-14(Aug. 1, 1963).

The K* vector meson is regarded as a P-wave resonance in the coupled, isotopic spin $\frac{1}{2}$, $\pi + K$, and $\eta + K$ states. All forces other than the K* and ρ exchange forces are neglected, and a modification of the self-consistency technique of Zachariasen and Zemach is used to calculate the K* mass and two relations among the three coupling-constant products $\gamma_{K^*\pi K^2}$, $\gamma_{K^*\eta K^2}$, and $\gamma_{\rho\pi\pi}\gamma_{\rho KK}$. The calculated K* mass agrees with experiment. The factors in the self-consistency equations that depend on the $\pi-\eta-K$ and $K^*-\rho$ mass differences are isolated, and the effects of these mass differences on the results are discussed. The relationship of the results to the predictions of unitary symmetry is discussed. (auth)

31337 ELECTROPRODUCTION OF NEUTRAL PIONS FROM DEUTERIUM. Stephen L. Brown (Purdue Univ., Lafayette, Ind.). Phys. Rev., 131: 1330-3(Aug. 1, 1963).

Making use of the impulse approximation and the one-nucleon dispersion theoretical amplitudes, a theoretical expression for the differential cross section of the process $e + d \rightarrow e + d + \pi^0$ has been calculated. An experiment which would be useful in the investigation of the nucleon form factors is proposed. At energies near the (3,3) resonance, the cross sections reach values up to 10^{-33} cm^2/Mev sr^2, depending on the electronic four-momentum transfer λ^2. (auth)

31338 THREE-BODY LEPTONIC DECAYS OF THE K MESONS. P. Dennery and H. Primakoff (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 131: 1334-44(Aug. 1, 1963).

A treatment is given of the three-body leptonic decays of the K mesons on the basis of a phenomenological strangeness-changing weak-interaction hamiltonian and an analysis is presented of the relevant decay form factors in terms of simple assumptions regarding the groups of eigenstates which are strongly coupled to the Kπ system. The possibility of a violation of time-reversal invariance arising from the "out of phaseness" of the strangeness-changing $\Delta T = \frac{3}{2}$ and $\Delta T = \frac{1}{2}$ currents in H_{weak} is considered. Throughout the discussion, the available experimental data are used to extract as much information as possible about the parameters which are important theoretically. (auth)

31339 RANGE OF HIGH-ENERGY INTERACTIONS. Freda Salzman (Univ. of Colorado, Boulder). Phys. Rev., 131: 1345-50(Aug. 1, 1963).

The range of high-energy nucleon-nucleon interactions is examined in a simple single inelastic channel model which consists of the production of two spinless isobars. An almost transparent, purely absorbing optical approximation is made, in which case both the inelastic and elastic angular distributions are sensitive to the variation of the absorption coefficient η_l with angular momentum l. Unlike the case of the strong absorber, the inelastic and elastic interactions are described by different effective ranges. Two examples are given, one in which the inelastic channel has an angular distribution characteristic of a one-pion exchange process and the second in which it is characteristic of a "vacuum Regge pole" exchange. (auth)

31340 MAGNETIC MOMENT OF THE POSITIVE MUON. David P. Hutchinson (Columbia Univ., New York),

Jack Menes, G. Shapiro, and A. M. Patlach. Phys. Rev., 131: 1351-62(Aug. 1, 1963).

The magnetic moment of the positive muon has been redetermined in terms of proton moments using a precession technique. The sensitivity achieved yields an error of 13 parts per million. The muons are stopped in various targets in a homogeneous magnetic field. The anisotropic distribution of the decay electrons relative to the muon spin direction permits the measurement of the spin precession frequency. The proton spin resonance is measured in the same field, yielding $f_\mu/f_p = 3.18338 \pm 0.00004$. This result may be combined with that of other experiments, the muon g factor, and the ratio of electron cyclotron frequency to proton resonance, f_e/f_p, to obtain a more precise evaluation of the muon mass in terms of electron masses, m_μ/m_e equals 206.765 ± 0.005. (auth)

31341 MAGNETIC MOMENT OF NEGATIVE MUONS. D. P. Hutchinson (Columbia Univ., New York), J. Menes, G. Shapiro, and A. M. Patlach. Phys. Rev., 131: 1362-7 (Aug. 1, 1963).

The magnetic moment of negative muons bound in atoms of carbon, oxygen (in water), magnesium (metallic and in MgH_2), silicon, and sulfur has been measured with a precision ranging from 3×10^{-5} in carbon to 1.6×10^{-4} in sulfur. The measured moment is corrected for relativistic effects, diamagnetism, and nuclear polarization before being compared to the moment of the positive muon. The two moments are found to be equal to 3×10^{-4}, where the major uncertainty is due to Knight shift. The relativistic, diamagnetic, nuclear, and solid-state shifts are large enough compared to the statistical and systematic errors to make this technique usable for the investigation of these effects. (auth)

31342 QUASIFREE PROTON-NEUTRON AND PROTON-PROTON SCATTERING AT 140 Mev. J. Lefrancois, R. A. Hoffman, E. H. Thorndike, and Richard Wilson (Harvard Univ., Cambridge, Mass.). Phys. Rev., 131: 1660-70(Aug. 15, 1963).

Measurements of the neutron-proton triple scattering parameters R and A have been performed by scattering a polarized proton beam on a deuterium target. Quasifree proton-neutron events were separated by requiring a time coincidence between the scattered proton and the recoil neutron. The quasifree results were corrected by the method of Cromer and Thorndike to give the following equivalent free neutron-proton results:

$\theta_{c.m.}$	R	A
42°	+0.169 ± 0.100	−0.020 ± 0.089
52½°	+0.080 ± 0.093	+0.070 ± 0.074
63°	−0.023 ± 0.073	+0.210 ± 0.088
73½°	−0.151 ± 0.095	+0.125 ± 0.105
83½°	−0.146 ± 0.210	+0.532 ± 0.220

Measurements were also made requiring a coincidence between the scattered proton and a recoil proton. In this manner, the R and A parameters for quasifree proton-proton scattering in deuterium were obtained. The results are:

$\theta_{c.m.}$	R	A
65½°	−0.246 ± 0.061	−0.229 ± 0.087
73½°	−0.273 ± 0.064	−0.144 ± 0.069
83½°	−0.050 ± 0.125	+0.016 ± 0.133

The free n-p values agree with the predictions of the Yale phase-shift solutions YLAN 3 and 3M. The quasifree p-p values agree with free p-p measurements. (auth)

31343 PROTON-DEUTERON ELASTIC TRIPLE SCATTERING AT 140 Mev. R. A. Hoffman, J. Lefrancois, and E. H. Thorndike (Harvard Univ., Cambridge, Mass.). Phys. Rev., 131: 1671-9(Aug. 15, 1963).

Measurements of the proton-deuteron elastic triple scattering parameters R and A have been made at the indicated laboratory energies. The following results were obtained:

θ_{lab}	R(140 Mev)	A(137½ Mev)
20°	0.404 ± 0.101	−0.377 ± 0.099
25°	0.180 ± 0.105	−0.301 ± 0.082
30°	0.064 ± 0.085	−0.038 ± 0.075
35°	−0.096 ± 0.092	+0.191 ± 0.074
40°	0.153 ± 0.156	• • •

Formulas, based on the impulse approximation, are given relating various elastic scattering parameters to nucleon-nucleon scattering amplitudes. The expressions were evaluated using nucleon-nucleon amplitudes of Breit and collaborators, and of Gammel and Thaler, and were compared with the R and A measurements, and with cross-section and polarization measurements of Postma and Wilson. The fit for solutions YLAN 3 and 3M is adequate for angles less than 45° lab. (auth)

31344 INTERPRETATION OF QUASIFREE PROTON-DEUTERON SCATTERING. A. H. Cromer (Northeastern Univ., Boston) and E. H. Thorndike. Phys. Rev., 131: 1680-9(Aug. 15, 1963).

Proton-deuteron inelastic scattering is studied in impulse approximation, using the formalism of Cromer. The S-wave final-state interaction of the two target nucleons is included. Expressions are evaluated for a scattering energy of 142 Mev. The results for quasifree scattering are compared with calculations of Everett. Results for quasifree p-p scattering are compared with measurements of cross section, polarization, and triple-scattering parameters R and A. Agreement for all but cross section is good, that for cross section is qualitatively right. Results for quasifree p-n scattering are used to obtain corrections relating quasifree measurements of P, R, A, and D to the free n-p parameters. These corrections are applied to the existing measurements of P, R, and A. Frequently, the corrections are larger than the experimental errors, and must be made before the data can be interpreted as n-p data. Scattering in which the target nucleons are left in a relative singlet spin state is considered, polarization parameters are evaluated, and methods for measuring them discussed. (auth)

31345 THRESHOLD EFFECTS IN n-d SCATTERING DUE TO THE EXISTENCE OF THE Di-NEUTRON. R. Alzetta (Università, Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Trieste, Italy), G. C. Ghirardi, and A. Rimini. Phys. Rev., 131: 1740-5(Aug. 15, 1963).

Use is made of a simple soluble model to evaluate the threshold effect which arises in the n-d scattering cross section if the di-neutron exists. The model contains four parameters. They permit a large set of experimental data to be reproduced remarkably well. Various binding energies of the hypothetical di-neutron are assumed. The effect is a rounded step. Its height is about 20% of the total cross section for any reasonable value of the binding energy, if the value 8.26 F is assumed for the n-d doublet scattering length. (auth)

31346 SEARCH FOR CHARGED PARTICLES WITH REST MASS BETWEEN THAT OF THE ELECTRON AND MUON. D. H. Coward, B. Gittelman, H. L. Lynch, and D. M. Ritson (Stanford Univ., Calif.). Phys. Rev., 131: 1782-6(Aug. 15, 1963).

Singly charged particles with rest mass between that of the electron and μ meson, produced by electromagnetic pair production, were searched for at the 1-Bev Stanford Electron Accelerator. The experiment had high sensitivity and when combined with theoretical electrodynamics results rules out the existence of any but very short-lived particles in the range from 1 to 175 m_e. (auth)

31347 RANGE OF VERY HIGH-ENERGY NUCLEON-NUCLEON COLLISIONS. Freda Salzman (Univ. of Colorado, Boulder). Phys. Rev., 131: 1786-96(Aug. 15, 1963).

The range of the chain-of-pions interaction is calculated for very high-energy nucleon-nucleon collisions in an approximation which does not require a complete dynamical description of the process. It is assumed that the chain-of-pions interaction is a primary process whose amplitude is not derived from that for "low-energy" processes. The interaction is described by two parameters, the average minimum-momentum transfer Δ_0 and the average fireball mass m_0. Certain results can be expressed in terms of Δ_0 and m_0 alone and are generally valid for all "linked-peripheral" models. In particular, if Δ_0 and m_0 are constant, then the inelasticity is constant, the number of fireballs is proportional to $\ln(s/M^2)$, where $s^{1/2}$ is the total barycentric energy, and the multiplicity is also proportional to $\ln(s/M^2)$. The chain-of-pions interaction in which the nucleons remain unexcited, N-N final states, is expected to be the most important process for small Δ_0 because of the considerably larger phase space available for it compared to that for isobar production. Thus, N-N final states give rise to the longest range part of the interaction and are estimated to make a larger contribution to the cross section than states in which even the $^3/_2$-$^3/_2$ pion-nucleon isobar is produced. An additional result is that the iterated dominant "low-energy" pion-exchange model gives a nucleon-nucleon cross section of at most several mb if only low values of the momentum transfer of one of the nucleons or isobars are allowed. With the approximations used, it is then possible to calculate the long-range part of the elastic diffraction scattering amplitude in the almost transparent, purely absorbing, optical approximation. We obtain the Regge behavior in the limit of a large number of fireballs. At incident nucleon laboratory energy $E_L = 10^3$ M, the amplitude has not yet reached the asymptotic limit. For $\Delta_0^2 = 5m_\pi^2$ and $m_0 = 2M$, one finds that the inelasticity is $^1/_3$, the number of "fireballs" is two, and the range is in close agreement with that given by the one-pole elastic Regge amplitude with $\alpha' = 1/M^2$. Finally, it is found that the nucleons which emerge unexcited in the final state lie within a cone whose angular width decreases with energy at a rate such that the transverse momentum P_T also decreases and $P_T \propto (\ln s)^{-1/2}$. This behavior is correlated to the shrinking of the elastic diffraction peak but is apparently in disagreement with high-energy events. (auth)

31348 EVIDENCE RELATING TO THE EXISTENCE OF THE f^0 RESONANCE. I. J. R. Aitchison (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 131: 1797-1801 (Aug. 15, 1963). (BNL-6841)

A one-pion-exchange calculation indicates that the small cross section for f^0 production observed in the reaction $\pi^+p \rightarrow \pi^+\pi^-\pi^+p$ need not contradict the large values observed in the reaction $\pi^-p \rightarrow \pi^+\pi^-n$. The two types of experiment are compared for a range of incident pion momenta. (auth)

31349 π^+-p ELASTIC SCATTERING AT 31.4 Mev. D. E. Knapp and K. F. Kinsey (Univ. of Rochester, N. Y.). Phys. Rev., 131: 1822-5(Aug. 15, 1963). (NYO-10257)

Five new measurements of π^- + p and three of π^+ + p elastic differential cross sections, extend the angular range and the accuracy of the data near 30 Mev. These data, combined with the previous measurements at this energy, provide a significant improvement in the accuracy of s- and nonresonant p-wave phase shifts. A phase-shift analysis yields four solutions, two of which are inconsistent with photoproduction measurements near threshold. One of the remaining two is preferred on the basis of a considerably more likely fit to recent charge-exchange measurements at the same energy. Assuming $f^2 = 0.0878$; $\alpha_1 = 0.087 \pm 0.009$; $\alpha_{11} = 0.051 \pm 0.008$, $\alpha_{13} = -0.043 \pm 0.004$; $\alpha_{31} = -0.008 \pm 0.002$; $\alpha_3 = -0.066 \pm 0.001$. (auth)

31350 π^--D SCATTERING AT 142 Mev. E. G. Pewitt, T. H. Fields, G. B. Yodh, J. G. Fetkovich, and M. Derrick (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 131: 1826-32(Aug. 15, 1963).

The interactions of 142-Mev π^- mesons with deuterium have been studied using a 15-cm bubble chamber in a 12.7 kG field. The angular distributions for elastic and inelastic scattering were measured. The elastic differential cross section for scattering angles greater than 90° is not in agreement with theoretical calculations based on the impulse approximation. The total cross section for neutral products ($2\underline{n}$, $2\underline{n} + \gamma$, $2\underline{n} + \pi^0$) was measured to be 37.2 ± 2.8 mb. The sum of the separate cross sections gave the $\pi^- + \underline{d}$ total cross section to be 183 ± 7 mb. (auth)

31351 PION-DEUTERON ELASTIC SCATTERING AT 142 Mev AND THE FORM-FACTOR APPROXIMATION. Hugh N. Pendleton (Brandeis Univ., Waltham, Mass.). Phys. Rev., 131: 1833-44(Aug. 15, 1963).

The differential cross section for charged pions with laboratory kinetic energy of 142 Mev to be scattered elastically by deuterons is calculated in a form-factor approximation which includes double scattering effects. The calculations also include effects produced by the D-state part of the deuteron wave function and the repulsive core in the neutron-proton interaction. A meson-theory derivation of an impulse-approximation series for the scattering amplitude using the Heitler-London method is described, as is an "optimal" procedure for obtaining a form-factor approximation to that series. The differences between the optimal form-factor approximation and other versions of the impulse approximation are discussed. The comparison of the calculations with experimental data indicates that pion-deuteron elastic scattering in the region of the first pion-nucleon resonance depends on off-energy-shell features of the pion-nucleon interaction which cannot be treated by a simple form-factor approximation. (auth)

31352 POLARIZATION OF PROTONS FROM THE HIGH-ENERGY PHOTODISINTEGRATION OF DEUTERIUM. F. J. Loeffler, T. R. Palfrey, Jr., and T. O. White, Jr. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 131: 1844-6(Aug. 15, 1963).

Photons with a mean energy of 294 Mev yielded photoprotons from a deuterium target at a mean angle of 58° in the laboratory. The protons were observed in a carbon-plate spark chamber and measurements of their elastic scattering in the carbon were used to determine the polarization components of the protons. The component parallel to the photodisintegration plane was found to be consistent with a value of zero within the statistical errors of the measurement as was expected. The component of polarization perpendicular to the photodisintegration plane was observed to be small and negative, and not inconsistent with a value of zero. (auth)

31353 CHIRALITY CONSERVATION AND SOFT-PION PRODUCTION IN PION-NUCLEON COLLISIONS. Ely Shrauner (Univ. of Chicago). Phys. Rev., 131: 1847-56 (Aug. 15, 1963).

The formalism for soft-pion emission previously developed on the basis of the hypothesis of chirality conservation is applied to the production of soft pions in pion-nucleon collisions. Specific predictions are calculated for the class of least inelastic production events in which extraneous effects such as final-state interactions are most nearly under control. For these events angular distributions of the inelastically scattered projectile pions are calculated very simply from the corresponding phenomenological elastic-scattering data. Comparison of these results is made with the only relevant experiment, and no contradiction is indicated with the angular distributions, although the magnitudes of the cross sections seem to be significantly underestimated by a factor of about 7. The high-energy predictions of the formalism are summarily indicated. The relation of the chirality conservation formalism to pion production in peripheral processes suggests that these processes are to be understood in terms of symmetry-violating effects. (auth)

31354 HARD-SPHERE BOSON GAS WITH WEAK ATTRACTION OR REPULSION. Richard J. Drachman (Brandeis Univ., Waltham, Mass.). Phys. Rev., 131: 1881-2(Aug. 15, 1963).

The coordinate-space variational treatment for the hard-sphere boson gas developed by Aviles and Iwamoto has been used to calculate the correction to the ground-state energy produced by a weak potential added outside the hard sphere. The first three terms in the low-density expansion are compared with the exact result of Wu. The first two terms agree well, while the third is poor. (auth)

31355 A MECHANISM FOR THE INDUCTION OF SYMMETRIES AMONG THE STRONG INTERACTIONS. R. E. Cutkosky (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 131: 1888-90(Aug. 15, 1963).

A model is constructed in which there are N equally massive vector mesons, which are self-consistent bound states of pairs of these same vector mesons. It is shown that N must be equal to the number of parameters of some compact, semisimple Lie group, and that the renormalized coupling constants must be proportional to the structure constants of the group. (auth)

31356 COULOMB GREEN'S FUNCTION IN CLOSED FORM. Levere Hostler and R. H. Pratt (Stanford Univ., Calif.). Phys. Rev. Letters, 10: 469-70(June 1, 1963).

A simple derivation of the nonrelativistic Green's function is given. Other representations of the function and their agreement with this and various other representations are discussed. (D.C.W.)

31357 THREE EXAMPLES OF THE $K^+ \rightarrow \pi^+ + \pi^- + e^+ + \nu$ DECAY MODE. V. Bisi, G. Borreani, R. Cester, et al. (Istituto Nazionale di Fisica Nucleare, Turin and Universita, Turin). Phys. Rev. Letters, 10: 498-500(June 1, 1963).

Three decays consistent with this scheme were observed in 30,000 pictures taken of a K^+ beam stopping in a hydrogen bubble chamber. Properties and pictures of the events are included, and an attempt is made to account for the missing energies and masses in the events. The ratio K_{e4}/τ was estimated to be about 10^{-3}, in agreement with experimental and theoretical results. No violation of the $\Delta Q = \Delta S$ rule by this decay was observed. (D.C.W.)

31358 ELECTRON-PROTON ELASTIC SCATTERING AT 1 AND 4 Bev. J. R. Dunning, Jr., K. W. Chen, N. F. Ramsey, J. R. Rees, W. Shlaer, J. K. Walker, and Richard Wilson (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 10: 500-4(June 1, 1963).

The cross section was measured at forward electron angles to detect possible deviations from the Rosenbluth formula. Data were obtained at 4-Bev incident electron energy with $q^2 = 6$, 10, 14, and 18 F^{-2}, and at 1 Bev with $q^2 = 6$, 10, and 14 F^{-2}. The results are consistent with a photon Regge trajectory of zero slope. A core term is indicated in the values of the proton's charge form factor extracted from the 4-Bev data. (auth)

31359 TOTAL CROSS SECTIONS AND SLOPE OF REGGE TRAJECTORIES. John M. Cornwall (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 10: 21-2 (July 1, 1963).

A simple upper bound on the total π-π cross section is shown to follow from partial-wave unitarity, where the bound on the residue $\beta(s)$ of the vacuum trajectory at $s = 0$ is a function of the slope $\alpha'(s)$ at $s = 0$. An effective-range calculation, taking into account the p-wave nature of the vacuum trajectory, gives a value of $\beta(o)$ that is more accurate than that arising from the unitary upper bound. The cross section is evaluated as 16 mb, in very good agreement with the expected 15 mb. (D.C.W.)

31360 RESOLUTION OF THE Σ^--MASS ANOMALY. Walter H. Barkas, John N. Dyer, and Harry H. Heckman (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 26-8(July 1, 1963). (UCRL-10837)

Ranges of the particles in $\Sigma^+ \rightarrow p + \pi^0$, $\Sigma^+ \rightarrow n + \pi^+$, $K^- + p \rightarrow \Sigma^+ + \pi^-$, $K^- + p \rightarrow \Sigma^- + \pi^+$ in emulsion were measured. From the mean excitational potential values required to obtain the proper masses and momentum balance in the processes, the best value of this potential was estimated to be 321 ± 8 ev. The following masses were derived: Σ^+, 1189.35 ± 0.15 Mev; K^-, 493.7 ± 0.3 Mev; Σ^-, 1197.6 ± 0.5 Mev; and Σ^0, 1193.2 ± 0.7 Mev. A hyperon (Σ^-) range of 708.9 ± 1.5 μ was observed in disagreement with the 684 ± 5 μ expected if the stopping cross sections of positive and negative particles were equal. (D.C.W.)

31361 OBSERVATION OF A DOUBLE HYPERFRAGMENT. M. Danysz (Univ. of Warsaw and Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw), K. Garbowska, J. Pniewski, et al. Phys. Rev. Letters, 10: 29-32 (July 1, 1963).

A hyperon (Ξ^-) emitted in the interaction of a 1.5-Bev/c meson (K^-) in emulsion was noted to have been absorbed with the production of a double hyperfragment. The ranges and angles involved in these and the subsequent decay processes are given. Analysis of the ordinary hyperfragment (subsequently emitted) showed the Ξ^- was captured on a light nucleus (C,N,O). Binding energies of the two Λ^0 hyperons in the double hyperfragment and the Λ^0 in the ordinary hyperfragment were determined. ${}_{\Lambda\Lambda}Be^{10-11}$ was probably formed by Ξ capture on carbon. (D.C.W.)

31362 PRODUCTION OF HYPERON RESONANCES IN $\Lambda^0 + \bar{\Lambda}^0 + \pi^+ + \pi^-$ FINAL STATES. C. Baltay (Yale Univ., New Haven), J. Sandweiss, H. Taft, et al. Phys. Rev. Letters, 10: 32-5(July 1, 1963). (BNL-7000)

Photographs of $\bar{p}$-p interactions in a hydrogen bubble chamber at incident energies of 3.25 and 3.69 Bev/c were examined for $\bar{p} + p \rightarrow \Lambda^0 + \bar{\Lambda}^0 + \pi^- + \pi^+$ reactions. Cross sections for the reaction at the two energies were found to be 15 ± 6 and 30 ± 9 ub, respectively. Mass spectra for all the Λ-π combinations were obtained, and Y_1^* (1385) and

$\bar{Y}_1^*$ (1385) production was clearly evident. It was concluded that at least half of the reactions of the above type involved Y_1^* or $\bar{Y}_1^*$ production and that some Y_1^{*-} and Y_1^{*+} pairs occurred. Λ-π angular distributions indicated that Y_1^* production does not proceed through a single-particle exchange mechanism. No three-body-resonance according to the known Λ-π-π decay mode of Y_0^* (1520) was noted; some evidence for a 1550-Mev resonance was observed. (D.C.W.)

31363 EXPERIMENTAL STUDY OF K_{e4}^+ DECAYS. R. W. Birge (Univ. of California, Berkeley), R. P. Ely, G. Gidal, et al. Phys. Rev. Letters, 10: 35-6(July 1, 1963). (TID-18940)

The selection rule $\Delta S = \Delta Q$ for axial-vector currents was tested by observing K^+ decay by the K_{e4} mode for a K^+ beam stopping in a heavy liquid chamber. 28,000 τ decays and 11 K_{e4} decays were observed, giving a partial decay rate by the K_{e4} mode of $(2 \pm 0.6) \times 10^3$ decays/sec. All the K_{e4} decays were $K^+ \rightarrow \pi^+ + \pi^- + e^+ + \nu$, in accordance with the rule. (D.C.W.)

31364 PHOTOPRODUCTION AND NEUTRAL DECAY MODES OF THE η PARTICLE. C. Bacci (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome), G. Penso, G. Salvini, A. Wattenberg, C. Mencuccini, R. Querzoli, and Silvestrini. Phys. Rev. Letters, 10: 37-42(July 1, 1963).

Photons of 978 and 939 Mev were focused on a liquid hydrogen target, H_2. A spark chamber combination measured the protons, and two methods (described) were used to detect the mesons (η). Proton energy spectra obtained both ways are included. The branching ratio $R = (\gamma + \gamma)/(3\pi^0) + (\pi^0 + \gamma + \gamma)$ and the differential cross section for photoproduction of η's decaying into $\gamma + \gamma$ were evaluated. The ratios of π^0 photoproduction to η photoproduction and of pion scattering to pion production of the η were determined to be 8 and 11, respectively. (D.C.W.)

31365 κ MESON [K*(725)] AND THE STRANGENESS-CHANGING CURRENTS OF UNITARY SYMMETRY. Yoichiro Nambu and J. J. Sakurai (Univ. of Chicago). Phys. Rev. Letters, 10: 42-5(July 1, 1963).

The hypothesis that the vector mesons M and $\bar{M}$ (to be identified with the observed K* meson of mass 885 Mev) are coupled to strangeness-conserving currents that are conserved as exactly as possible is examined in the framework of unitary symmetry. The hypothesis is shown to suggest the existence of $Y = \pm 1$, $T = \frac{1}{2}$, and $J = 0^+$ mesons (with no unitary partners) whose couplings to other strongly interacting particles vanish in the limit of exact unitary symmetry. The possible connection between the conjectured scalar meson and the experimentally observed κ meson (725-Mev meson (K*)) is discussed. (auth)

31366 MODIFIED PHASE SHIFT ANALYSIS OF PION-NUCLEON SCATTERING DATA. G. L. Kane and T. D. Spearman (Univ. of Illinois, Urbana). Phys. Rev. Letters, 10: 45-8(July 1, 1963).

A method is presented for analyzing π-N scattering data using phase shifts for the low partial waves and a closed term to represent the effect of all higher partial waves. The closed term is calculated on the basis of the analytic properties of the scattering amplitude in the complex $\cos\theta$ plane. The method is applied to π^+-p angular distribution and polarization data at 310 Mev and removes ambiguous results obtained in a conventional phase shift analysis when f-wave phase shifts were included. Values for the $T = \frac{3}{2}$ π-N phase shifts at 310 Mev are obtained. (auth)

31367 $\varphi\omega$ MIXING. S. L. Glashow (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 48-9(July 1, 1963).

The possibility that the nine known strongly interacting vector mesons comprise a unitary octet and a unitary singlet is considered. Symmetry breakdown is assumed to result from a mixing of the singlet with the $T = Y = 0$ member of the octet. The couplings of the vector mesons are assumed to be otherwise invariant under the transformations of the eightfold way. Because of the mixing, the particle eigenstates, ω and φ, are linear combinations of ω_1 (the unitary singlet) and ω_8 (the $T = Y = 0$ member of the octet). An attempt is made to relate the mixing angle Θ in these combinations to coupling constants, form factors, etc. (auth)

31368 UNITARY SYMMETRY AND DECAY OF η MESON. Susumu Okubo (Univ. of Rochester, N. Y.) and Bunji Sakita. Phys. Rev. Letters, 10: 50-2(July 1, 1963). (TID-18655)

The $\eta \rightarrow \gamma + \gamma$, $\eta \rightarrow \pi^+ + \pi^- + \pi^0$ (or $3\pi^0$), $\eta \rightarrow \pi^+ + \pi^- + \gamma$, and $\eta \rightarrow \pi^0 + \gamma + \gamma$ decay modes are investigated in connection with the unitary symmetry model. Decay rates are computed in lowest order with respect to the electromagnetic interactions. Values of Γ of 142 ± 28 ev, 147 ev, 82 and 7 ev, and 8 ev are determined for the four modes, respectively. Values for the first two processes are noted to be capable of agreement with the experimental branching ratio. (D.C.W.)

31369 DETERMINATION OF SPIN AND DECAY PARAMETERS OF FERMION STATES. N. Byers and S. Fenster (Univ. of California, Los Angeles). Phys. Rev. Letters, 10: 52-5(July 1, 1963).

The decay process $Y^* \rightarrow Y + \pi$, where Y^* has spin J and decays into a particle with spin $\frac{1}{2}$ (Y) and one with spin zero (π), is considered. It is shown how J and the amplitudes for the parity states $l = J + \frac{1}{2}$ may be measured if the transverse and longitudinal polarizations of Y are appreciable. (auth)

31370 SHRINKAGE OF THE DIFFRACTION PATTERN AND SHORT-RANGE FORCES. Bipin R. Desai (Indiana Univ., Bloomington). Phys. Rev. Letters, 10: 59-62(July 1, 1963).

The observed shrinkage of the diffraction pattern in p-p, but not in π^--p, scattering is considered. Representation of the π^--p differential cross section in terms of the Pomeranchuk trajectory alone is shown to give good agreement with diffraction data. In p-p scattering the Pomeranchuk term determines the low momentum transfer behavior of the cross section, while at about 10 Bev/c the term due to ω exchange (not present in π^--p) becomes important. ω-exchange is also present in K^+-p scattering; this diffraction pattern should show shrinkage similar to the p-p and $\bar{p}$-p shrinkage. (D.C.W.)

31371 TWO POSSIBLE METHODS OF MEASURING PARTICLE BEAMS OF MEDIUM ENERGY. V. P. Zrelov (Joint Inst. of Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 2, 29-33(Mar.-Apr. 1963). (In Russian)

Two new methods for measuring relativistic particle beams of medium energy were proposed. The first method was based on the diffraction of Cherenkov radiation. In the second method the rotation of surface polarization of Cherenkov radiation in optically active media was used. (tr-auth)

31372 S-WAVE $\bar{K}N$ REACTIONS AS TWO-CHANNEL PROBLEM. Yasunori Fujii (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 29: 574-89(Apr. 1963). (In English)

A two-channel formalism is applied to the problems concerning the S-wave $\bar{K}N$ reactions in the $I = 0$ state. The

$\pi\Sigma$ channel coupled with the S-wave $\bar{K}N$ channel is assumed to be either in $S_{1/2}$-state or in $P_{1/2}$-state. In the analysis $\pi\Sigma$ scattering below $\bar{K}N$ threshold is particularly investigated with an attention to the Y_0^* recently observed (1405 Mev, $I = 0$). If Y_0^* has such spin and parity as to couple to the S-wave $\bar{K}N$ channel, then Humphrey and Ross's first solution for the $\bar{K}N$ scattering length is excluded because of a too large imaginary part, while the second solution seems not inconsistent, though a smaller imaginary part may be favored. The mechanism of such Y_0^* is discussed to give a conclusion that it is an inelastic resonance, an example of which is the so-called bound state resonance. (auth)

31373 ON THE COUPLING CONSTANTS OF STRONG INTERACTIONS. Kazo Nakazawa (Kyoto Univ.), Masako Bando, and Reiji Sugano. Progr. Theoret. Phys. (Kyoto), 29: 590-602(Apr. 1963). (In English)

The coupling constants of strong interactions are given by considering Y^*'s and other experimental results that include Ξ. It is shown that Y_1^* (1385 Mev), Y_0^* (1405 Mev), and Y_1^* (1550 Mev) can be regarded as analogues of $N_{3/2}^*$, the (3-3) resonance. If the spin-parity of Y_0^* is $P_{1/2}$, it may be concluded that $g^2_{\Sigma\Sigma\pi} \approx 0$, $g^2_{\Lambda\Sigma\pi} \approx g^2_{NN\pi}$, $g^2_{\Sigma NK} \approx 0$, and $g^2_{\Lambda NK} = 1 \sim 3$, where g's are ps-coupling constants of the vertices indicated by the suffixes. In this case it follows necessarily that the resonant state with the isotopic spin 2 appears in Σ-π scattering, but it may have a rather broad peak. The coupling constants of π and K to Ξ are also discussed. And then a possible choice for the coupling constants is obtained along the Miyazawa, Nakano, and Umezawa hypothesis. (auth)

31374 THEORY OF MANY-BOSON SYSTEMS. PAIR APPROXIMATION AND THE JASTROW TRIAL PAIR FUNCTION. V. H. Smith, Jr. and H. A. Gersch (Georgia Inst. of Tech., Atlanta). Progr. Theoret. Phys. (Kyoto), 29: 605-7(Apr. 1963). (In English)

A perturbation theory approximation is applied to the many-boson problem to obtain a parametric trial pair function similar to that derived by Jastrow. The major contribution to the ground state energy from single pair excitations is evaluated by a direct calculation in configuration space. This treatment is similar to the direct evaluation of the second virial coefficient for imperfect gases. The perturbation theory connection is shown at an early stage before the full formalism of the cluster development is introduced. This serves to motivate the general method of cluster integrals that may be so treated to be completely equivalent to the perturbation theory in the approximation of pair excitations. (C.E.S.)

31375 A NOTE ON THE GENERALIZATION OF THE MINAMI AMBIGUITY. Ching-hung Woo (Columbia Univ., New York). Progr. Theoret. Phys. (Kyoto), 29: 609-10 (Apr. 1963). (In English)

Generalization of the Minami ambiguity for meson (π)-nucleon scattering to the case of arbitrary spins and to cases where both interacting particles have spins was accomplished by considering the helicity scattering amplitudes of the interacting particles. A transformation of the S-matrix for the scattering amplitudes in helicity states corresponding to a change in the sign of the phase-shifts was applied. Transformations on the phase matrix for the case of arbitrary spins and for both interacting particles having spins were presented. (C.E.S.)

31376 MASS RULES FOR BARYONS AND RESONANT STATES. Takehiko Takabayasi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 29: 614-16(Apr. 1963). (In English)

The formula that expresses the baryon mass in terms of internal quantum numbers is generalized so as to apply to the low-lying baryon resonances. Simple relations that systematize masses of all other known baryon resonant states are also presented. (C.E.S.)

31377 A MEASUREMENT OF THE SPIN CORRELATION COEFFICIENT C_{KP} IN p-p SCATTERING AT 52 Mev. Keigo Nisimura (Tokyo Univ.), Junpei Sanada, Shinsaku Kobayashi, Kiyoji Fukunaga, Norio Ryu, Hiromi Hasai, D. C. Worth, Hitoshi Imada, Yukio Hiratate, and Takeo Hasegawa. Progr. Theoret. Phys. (Kyoto), 29: 616-17 (Apr. 1963). (In English)

The spin correlation coefficient in proton-proton scattering at 90° in the center-of-mass system was measured at 52 Mev. The spin correlation coefficient is highly sensitive to the phase shift of 3 Po, and information on the character of the spin-orbit coupling force can be obtained by measurements in this energy region. The spin correlation coefficient was found to be 0.10 ± 0.14. This result seems to require a rather large value for the 3 Po phase shift and indicates that the spin-orbit coupling force in this energy region is weaker than that inferred from high-energy experiments. (C.E.S.)

31378 PROTON-PROTON SCATTERING AT 52 Mev. Norio Hoshizaki (Kyoto Univ.), Shoichiro Otsuki, Ryozo Tamagaki, and Wataro Watari. Progr. Theoret. Phys. (Kyoto), 29: 617-19(Apr. 1963). (In English)

Data from proton-proton scattering at 52 Mev were used to obtain information on the spin-orbit coupling force. A 6-parameter phase shift analysis by the least squares method was made, assuming that the partial waves with $L \geq 3$ are correctly represented by the one-pion-exchange contribution and that the $^1D_2$ phase has a reasonable positive value from one to two degrees. The solution seems to indicate that the effect of the spin-orbit coupling force at low energies is not as strong as at 310 Mev. This may indicate that the spin-orbit coupling force is quite short-ranged. (C.E.S.)

31379 DETERMINATION OF THE ANALYTICITY REGIONS OF FEYNMAN INTEGRALS CORRESPONDING TO THE NUCLEON-NUCLEON, PION-NUCLEON, AND K-MESON-NUCLEON SCATTERING. I. I. Kostyrko. Ukr. Mat. Zh., 14: 411-17(1962).

The analyticity regions are determined on the basis of a previously proposed general integral representation. Inequalities are derived for the regions also. (TCO)

31380 EFFECTIVE TARGET MASS FOR NUCLEON INTERACTIONS AT 10^{12} ev. 4p. (CONF-23-8)

From American Physical Society Meeting, St. Louis, Mar. 1963.

The conservation laws of energy and momenta give relations on the basis of which N-N interactions can be distinguished from nucleon-nucleus interactions. A relation for the effective mass of the target nucleon that participates in the interaction allows determination of this mass from the momenta of the shower particles or from the angular distribution of the shower particles. Analysis of N-N and π-N interactions at about 10^{12} indicates that these interactions take place through peripheral collisions and also support the presence of structure in the nucleons. (D.C.W.)

31381 THE ESCAPE MECHANISM OF SECONDARY ELECTRONS IN POLAR CRYSTALS. Waman Sadasheo Khokley. Thesis, Minneapolis, Univ. of Minnesota, 1962. 104p.

A theory for the motion and escape of secondary electrons produced inside a polar crystal by electron bombardment is proposed here. This attempt to interpret some experimental features as observed in MgO is based on the formalism of the Boltzmann transport equation. It was assumed that: the incidence of the primary beam is such that the spatial dependence of the internal secondary-electron distribution is one-dimensional; the secondary electrons move in a simple conduction band; $\epsilon = \hbar^2 k^2/2m^*$ where the energy ϵ is measured relative to the bottom of the conduction band; m^* is the isotropic effective mass; the electrons interact only with the optical modes of the lattice vibrations, to which we assign the same frequency ω; and the mean free path λ depends only on $|\underline{k}|$, and not on the direction of motion. The scattering probabilities are obtained from the theory of electron-phonon interaction following Fröhlich and modified by Dekker for secondary electrons. The scattering mechanism is such that a secondary loses energy per collision at the average with an emission of a phonon while its direction of motion is essentially unchanged. However, the collision integrals are simplified by defining a mean free path and approximating the scattering probabilities by delta-functions. The approximations seem to be reasonable for electron energies much larger than the average energy loss per collision and for those collisions where modes of vibrations with long wave lengths are involved. The choice of the source-density function in the transport equation is semi-empirical. The space dependence of the internally created secondaries is chosen intuitively from experimentally established results. Calculations are carried out for a plane source and for a uniform volume source. The energy dependence of the produced secondaries is taken as ϵ^{-2} from theoretical considerations essentially of an interband transition type. The angular dependence of the electron source is taken as isotropic lacking definite information. The escape mechanism is dealt with for the case of a plane surface with a potential barrier. A current density is defined for electrons emerging with energy between ϵ and $\epsilon + d\epsilon$ at an angle between θ and $\theta + d\theta$ with respect to the axis normal to the surface. The dependence of the current density on θ and ϵ is referred to as the energy angular distribution. Integration over θ gives the energy dependence, while integrating over ϵ yields angular dependence of the outcoming secondaries. The dependence on surface potential is calculated by integrating over both ϵ and θ. First the transport equation is solved without the field term and the various dependences are compared with experimental results. Then a solution is obtained for small electric fields by perturbation treatment. Again the enhancement or dehancement by a field is compared to observed magnitudes. The maximum of the energy dependence for a plane source situated at the range of primaries occurs at a value about thrice the value observed experimentally; the variation of the secondary yield with a small electric field is about $\frac{1}{2}$ to $\frac{1}{3}$ of the one observed by measurements. The theory shows clearly the difference in scattering processes in metals from those in insulators. One could also infer that the spatial distribution of sources does not change appreciably with primary energy, but the production of low energy secondaries is favored for high energy primaries. (auth)

31382 FORM FACTORS IN THE PIONIC DECAYS OF HYPERONS. Samuel Laurie Greene, Jr. Thesis, Syracuse, N. Y., Syracuse Univ., 1962. 153p.

The pionic decays of hyperons form one of the more curious portions of contemporary high-energy physics. These decays present a theoretical jungle whose growth appears to vary inversely with the experimental rainfall. In an attempt to uncover some small part of the nature of this growth, we calculate form factors for the pionic decays of hyperons using the techniques of dispersion relations. We remove the hyperon from the mass shell and expand the resulting matrix element for hyperon pionic decays into a sum of four form factors. Assuming the usual cut-plane of analyticity for these form factors, we calculate their imaginary parts in the approximation of retaining only the contributions from the intermediate nucleon state and the intermediate pion-baryon state. We thereby obtain and solve well-known types of uncoupled singular integral equations for the form factors governing transitions into the various allowed final states of orbital angular momentum and isotopic spin. In the solutions, the contribution from the intermediate pion-baryon state appears as a correction (due to final state interactions) to the contribution from the intermediate nucleon state (the pole term). This correction appears as the exponential of an integral A; A is an integral over one of the baryon-pion scattering phase shifts corresponding to the angular momentum states $S^1/_2$ or $P^1/_2$ for a given isotopic spin state. Since these phase shifts are known only over a small range of momenta, whereas A is an integral from threshold to infinity, we have inserted, in place of the phase shifts, a function which simulates the known phase shift behavior at threshold and the conjectured behavior at infinity and varies smoothly between. In this way we find the correction due to final state interactions to be less than about 25%. (auth)

31383 ELASTIC SCATTERING OF NEGATIVE MUONS IN NUCLEAR EMULSION. David Kotelchuck. Thesis, New York, Cornell Univ., 1963. 49p.

An emulsion stack was exposed to a separated beam of $\sim 2 \times 10^7$ μ^- particles of energy 52 ± 8 Mev at the CERN synchrocyclotron. Mesons(μ) with endings in a region near the incoming edge of the plates were traced back to scatters, thus discriminating in favor of events with momentum transfers from 100–160 Mev/c. The 78 events found give evidence that the meson(μ) behaves merely as a heavy electron, in contradiction to the anomalous meson(μ)-nucleus scattering reported in several cosmic ray experiments. The data indicate, however, a possibility of a small amount of scattering in excess of that predicted, particularly for momentum transfers >130 Mev/c. This may be ascribed either to unresolvable inelastic scattering, to inaccuracies in the parameters of the nuclear charge distribution, or to the breakdown in the representation of the many-body nucleus by a smoothed-out potential. Of the 78 events, one was an elastic scatter by hydrogen, which is consistent with the Mott scattering formula. (auth)

Neutron Physics

31384 (HW-78288) PROGRAM KERNEL. C. W. Lindenmeier, D. D. Matsumoto, and D. R. Skeen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 17, 1963. Contract AT(45-1)-1350. 11p.

Program KERNEL generates scattering kernels based on Nelkin's model. The first four Legendre moments are calculated by integrating the Nelkin equation over the angle. Various quantities requiring integration over final energy are also computed. Data preparation, output, and the code SETUP, which may be used to derive input parameters for

KERNEL, are discussed. The equations and input quantities for polyethylene and water are described. (auth)

31385 (JEN-114-DF/1-33) EXTENSION DEL CAMPO DE VALIDEZ DE LA TEORIA DE DIFUSION PARA NEUTRONES TERMICOS EN LAS PROXIMIDADES DE BORDES. (An Extension of Diffusion Theory for Thermal Neutrons Near Boundaries). J. L. Alvarez Rivas (Spain. Junta de Energiá Nuclear, Madrid). 1963. 69p.

The validity of elemental diffusion theory for determining the thermal neutron flux distribution in the region of a boundary between two dissimilar materials is examined. The theory is explained, and results of experiments with copper rods in light water are analyzed. The results show the distributions can be calculated with this theory if the diffusion coefficient of the rod (now dependent on the geometry as well as the material) is changed properly. An expression for the diffusion coefficient that gives results in satisfactory agreement with experiment is introduced. (D.C.W.)

31386 THE EIGENVALUES OF WILKIN'S EQUATION. K. Meyer (VEB EPkA, Berlin). Kernenergie, 6: 202-7 (May 1963). (In German)

The first coefficients of the power series for the eigenvalues of Wilkin's equation were summed up and reduced to finite sums, which contained only well-known constants. The obtained expressions allowed the calculation of the eigenvalues in this approximation with little expenditure. The transformations were performed with the help of the properties of the hypergeometric functions. (tr-auth)

31387 NEUTRON SCATTERING BY AN ANHARMONIC CRYSTAL. B. V. Thompson (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 131: 1420-7(Aug. 15, 1963).

Baym's treatment of coherent scattering of slow neutrons by a crystal is examined and modified to include effects due to the cubic-anharmonic term in the lattice potential to second order in the coupling constant. Corrections to the Debye-Waller factor and to the "one-phonon" resonance peak are obtained, which appear to be negligible ($\approx 0.01\%$) for the case of a Bravais lattice and certainly $<1\%$ in other cases. (auth)

31388 SCATTERING OF SLOW NEUTRONS BY LIQUID H_2S. H. Rżany and J. Ściesiński (Inst. of Nuclear Physics, Krakow). Physica, 29: 488-90(May 1963).

The total scattering cross section in liquid H_2S was measured for neutrons in the energy range 0.0058 to 0.187 ev. The results were compared with the gaseous H_2S cross section and with the Krieger-Nelkin curve. An evidence of a slight hindrance of molecular rotations was obtained. (auth)

Nuclear Properties and Reactions

Refer also to abstracts 29951, 29953, 29956, 29990, 30085, 30125, 30159, 30160, 30161, 30164, 30165, 30167, 30731, 30855, 31053, 31056, and 31758.

31389 (ARF-A6027-2) STUDIES OF THE RESONANCE INTEGRALS OF Re AND Tm. Monthly Progress Report, May 1, 1963–May 31, 1963. William E. Zagotta (Illinois Inst. of Tech., Chicago. IIT Research Inst.). June 5, 1963. Contract AT(11-1)-578. 6p.

The branching ratio for the beta decay of Tm^{170} was determined to be 0.22 with an uncertainty of 2%, and the internal conversion coefficient of Yb^{170} was determined by two different methods to be 7.27 and 6.6 ± 0.5, respectively. Preliminary work on resonance integral and reactivity measured is described. (D.C.W.)

31390 (CEA-2287) PROGRAMME FORTRAN POUR LA DIFFUSION ELASTIQUE DE DEUTONS AVEC UN MODELE OPTIQUE CONTENANT DES TERMES TENSORIELS. (A FORTRAN Program for Elastic Scattering of Deuterons with an Optical Model Containing Tensorial Potentials). J. Raynal (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 163p.

The FORTRAN program 5PM 037 calculates the effective elastic scattering cross section, polarizations, the effective total reaction cross section, and the polarization transfer coefficients for spin-1 particles of low charge and mass incident on a low charge and mass target at medium energy. The number of partial waves can not exceed 38, and calculations for different values of parameters for the optical model used can be made. The effect of tensorial potentials constructed from the distance of the deuteron from the target, and its angular momentum with respect to it, can also be studied. The optical model, necessary data, numerical methods, and description of the problem are discussed. The program is described, and tables of equivalent statements necessary for modifying it are included. (auth)

31391 (CONF-12-2) VARIATION IN U^{235} MASS YIELDS AT NEUTRON ENERGIES BELOW 0.5 ev. K. T. Faler and R. L. Tromp (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). [1962]. Contract [AT (10-1)-205]. 18p.

From 8th Annual Meeting, American Nuclear Society, Boston, June 1962.

Variations in the shape of the fission-product mass yield distribution curve when U^{235} is irradiated with neutrons of various energies up to 0.5 ev were studied by radiochemical measurements of peak-to-valley ratios. A >30% increase in the relative amount of symmetric fission was found at the peak of the 0.29 ev resonance compared to the amount of symmetric fission produced with thermal neutrons. A decrease in the amount of symmetric fission was observed at increasing neutron energies where symmetric fission was 18% less common with epi-cadmium pile neutrons than with those at thermal energy. At neutron energies below 0.01 ev a sudden increase in the relative amount of symmetric fission was also found, even though there is no evidence from cross-section data for a resonance in this energy region. The results of this study are compared with those of other investigations at higher neutron energies. A discussion is presented regarding implications of mass-yield variations in the theory of fission through saddle-point states. (auth)

31392 (CONF-46-3) DECAY OF THE Sb^{126} ISOMERS. B. J. Dropesky and C. J. Orth (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 8p.

From American Physical Society Meeting, Washington, D. C., Apr. 1963.

Radiations from the 19-min and 12.5-day isomers were studied by single-crystal and coincidence spectrometry. Beta spectra of both isomers have 1.90 ± 0.15-Mev maximum energies; the 19-min. isomer spectrum shows a single β component, while that of the other isomer appears complex. The 19-min. isomer decays about 85% by β transition to Te^{126} and about 15% by I.T. to the 12.5-day Sb^{126} ground state. Evidence for an I.T. energy ≤ 30 kev is noted. The energies of the gamma rays observed are included as well as a proposed decay scheme, a 1.78-Mev level of which is postulated to be predominately a two

quasi-particle state with the proton configuration $(d_{5/2}, g_{7/2})_{6+}$. Spin and parity assignments of 5^+ and 8^- are proposed for the 19-min and 12.5-day isomers, respectively. (auth)

31393 (CONF-46-6) QUANTITATIVE THEORY OF NUCLEAR EVAPORATION AND ITS RELATION TO NUCLEAR MATTER. David B. Beard and Alden McLellan (California. Univ., Davis). Feb. 1, 1963. Contract AT(11-1)-34. 37p.

From American Physical Society Meeting, Washington, D. C., Apr. 1963.

The energy level densities of nucleons in a diffuse nuclear well are calculated using an Eckart-Bethe (Woods-Saxon) potential and are shown to be a more sensitive function of energy than the calculated densities of nucleons in a square well having the same volume. The particle spectra for 14-Mev inelastically scattered neutrons are computed including multiple neutron emission and are shown to fit experimentally observed spectra well within the experimental error. This fit is obtained with no parameter fitting of theoretically undetermined constants. Formulas are derived by which experimentally determined particle spectra from highly excited nuclei may be reduced to single particle emission spectra. These, in turn, are interpreted in terms of the diffuseness of the nuclear well at high excitation energies so as to yield the compressibility of nuclear matter. 28 references. (auth)

31394 (CONF-46-22) NEUTRON ACTIVATION CROSS SECTION FOR Br^{79}, Br^{81}, Rh^{103}, In^{115}, AND I^{127}. S. A. Cox (Argonne National Lab., Ill.). May 1963. Contract [W-31-109-eng-38]. 22p.

From American Physical Society Meeting, Washington, D. C., April, 1963.

Thin disks of the elements were irradiated with neutrons from the Li(p,n) reaction, and the activation cross sections were determined by measuring the activity due to fast neutron capture relative to that for thermal neutron capture. The results are graphically displayed and are compared with existing activation measurements. The activation measurements are combined to form the total neutron absorption cross section, which is compared with capture gamma-ray measurements made with a large liquid scintillator. (D.C.W.)

31395 (CONF-46-23) THE THEORY OF DIRECT NUCLEAR KNOCK-OUT REACTIONS (thesis). Jae Young Park (North Carolina. Univ., Chapel Hill). 1962. Contract AT(40-1)-2408. 161p.

From American Physical Society Meeting, Washington, D. C., April 1963.

The general formalism of direct nuclear reactions at intermediate energies is developed on the assumption that the reaction proceeds via a knock-out mechanism. Taking the example of an (α,N) reaction, where N stands for a spin $\frac{1}{2}$ particle, such as a nucleon, or a triton or He^3 nucleus whose structure can be neglected, calculations are carried out in the distorted wave Born approximation. The effects of the spin-dependent distortions in the initial and final states appear in radial wave functions and phase shifts that characterize the partial wave expansions. A finite-range, spin-independent direct interaction between α and N is used. Explicit formulas are obtained for the differential cross section, the polarization of the emitted particles, and the angular correlation between the emitted particles and γ-rays from subsequent decay of the final nucleus. By use of Racah algebra, all sums over magnetic substates are performed. The angular distribution of the emitted particles relative to the incident beam is expressed as a series of Legendre polynomials, all coefficients being manifestly real. Similarly, by the use of the density matrix, the general expression for the polarization is obtained as a series of associated Legendre functions. Several special cases are worked out in detail, such as S-state to S-state transitions, and the simplifications which occur for a zero-range direct interaction are considered. The applicability of the present theory to various types of nuclear reactions is discussed and its possible utility in studying the nuclear reaction mechanism, the cluster structure of nuclei, and the nature of the nuclear surface is pointed out. It is shown how this well-defined model of a particular reaction mechanism can serve to shed light on the accuracy of various common approximations, such as the Plane Wave Born Approximation, the assumption of a Surface Interaction, and the neglect of the finite range of the direct interaction. Some numerical illustrations are given, but no detailed machine computations are presented. 68 references. (auth)

31396 (CONF-46-28) MULTIPLE COULOMB EXCITATION OF ROTATIONAL LEVELS IN EVEN-EVEN NUCLEI. J. de Boer, G. Goldring, and H. Winkler (California Inst. of Tech., Pasadena). [1962]. Contract [AT(11-1)-68]. 17p.

From American Physical Society Meeting, Washington, D. C., April, 1963.

Seventeen deformed even-even nuclei of the rare earth region were bombarded with 30 to 44-Mev oxygen ions. The Coulomb excitation process was studied by observing the gamma radiation depopulation the excited rotational levels. Excitation probabilities were determined and compared with values obtained by calculations with the rotational model in the sudden approximation. Very good agreement was attained. Cascade gamma energies (new transitions were observed), internal conversion coefficients, quadrupole moments, and probabilities are listed. (D.C.W.)

31397 (CONF-46-29) AN INVESTIGATION OF THE DECAY PROPERTIES OF P^{30} (thesis). Richard A. Moore (Kansas. Univ., Lawrence. Nuclear Physics Lab.). Feb. 1963. Contract [AT(11-1)-1120]. 118p.

From American Physical Society Meeting, Washington, D. C., April 1963.

Spectral measurements were made on ten resonances occurring in the proton radiative capture reaction on Si^{29} in the proton energy range from 1 to 1.85 Mev. Decay schemes for the compound nucleus P^{30} thus formed were proposed for the seven resonance levels at 1302, 1470, 1505, 1640, 1686, 1748, and 1772 kv. Coincidence spectrometer measurements and intensity measurements show the following results for branching ratios of intermediate excited levels: for the 4.62-Mev level, a branching ratio of 86 : 14 for transitions to levels 3 and 2; for the 4.23-Mev level, a branching ratio of 10 : 64 : 26 for transitions to levels 0, 4, and 5; for the 4.14-Mev level, a branching ratio of 88 : 12 for transitions to levels 0 and 3; for the 2.84-Mev level, a 100% transition to the ground state. Branching ratios of other levels are found to be consistent with previously reported work. Angular distribution measurements were performed at the resonances formed at proton energies of 1302, 1505, and 1686 kv. The results of these measurements show J^π (1302) = 1+; J^π (1505) = 2+; J^π (1686) = 2+. Results for intermediate excited levels show j^π (4.23-Mev level) = 2+; j^π (2.54-Mev level) = 3+; j (4.50-Mev level) consistent with spin zero. Theoretical angular distributions for the general case of spin-$\frac{1}{2}$ particles incident on spin-$\frac{1}{2}$ nuclei were calculated for decay

radiations from the resonance level for various spins and parities, and for intermediate-unobserved radiations terminating in a 1+ level. The maxima and minima of the coefficients in the theoretical distributions were computed for all these cases. 40 references. (auth)

31398 (CONF-46-37) FISSION CROSS SECTION OF Pu^{239}. D. K. Butler and R. K. Sjoblom (Argonne National Lab., Ill.). [nd]. Contract [W-31-109-eng-38]. 16p.

From American Physical Society Meeting, Washington, D. C., April, 1963.

The cross section for neutron induced fission of Pu^{239} was measured from 0.4 to 1.4 Mev. The measurement was made by determining the ratio of the Pu^{239} cross section to that of U^{235} using a back to back gas scintillation counter. The neutrons were produced by the $Li^7(p,n)Be^7$ reaction with protons from an electrostatic generator. Preliminary results show that the cross section rises from a low value at the lowest energies to reach 2.9 barns at 1.0 Mev. Above this energy, it begins to level off as if to form the plateaux characteristic of fission cross sections in this energy region. The significance of the unusually high cross section to fission systematics is discussed. (auth)

31399 (CONF-62-8) MECHANISMS OF NUCLEAR REACTIONS BETWEEN LITHIUM NUCLEI. S. K. Allison, M. Kamegai, and G. C. Morrison (Chicago. Univ.). [1963]. Contract AT(11-1)-636. 9p.

From Conference on Reactions Between Complex Nuclei, Asilomar, Calif., Apr. 1963.

Double coincidence measurements of the angles and energies of two alpha particles from the reaction $Li^6 + Li^6 \rightarrow 3\alpha + 20.90$ Mev indicated that the reaction must proceed by a cluster process. The data are consistent with a Li^6 nucleus attaching itself to a deuteron cluster, the two most likely coalescing into a Be^8 excited state at 20.95 ± 0.3 Mev, leaving $21.85 - 20.95 = 0.90$ Mev to be divided in the kinetic energies of separation of the Be^{8*} and the remaining alpha. (D.C.W.)

31400 (CONF-62-9) THE $B^{10}(d,Li^6)Li^6$ REACTION AT DEUTERON ENERGIES FROM 8 TO 13.5 Mev. D. S. Gemmell, J. R. Erskine, and J. P. Schiffer (Argonne National Lab., Ill.). [1963]. Contract [W-31-109-eng-38]. 12p.

From 3rd Conference on Reactions Between Complex Nuclei Asilomar, California, April 1963.

Angular distributions and cross sections were measured by coincidence detection of the Li^6 pairs for deuteron energies of 8, 10, 12, and 13.5 Mev. The distributions show strong peaking at about 40 and 140°, together with a fall-off in the cross section toward 0° and 180°. The 8-Mev distribution shows the effect of the strong Coulomb barrier on the cross section. The cross section decreases rapidly for deuteron energy decreases from 8 to 4.85 Mev, and the angular distribution also changes markedly. A DWBA calculation for an $l = 2$ α-particle transfer afforded a check on the presence of a direct interaction mechanism at high energy. The calculation fit the peaking at 40 and 140°. (D.C.W.)

31401 (EANDC-E-39L) THERMAL ACTIVATION CROSS SECTIONS AND RESONANCE INTEGRALS OF In^{115}. K. H. Beckurts, M. Brose, M. Charpenet, G. Krueger, W. Poenitz, and H. Schmidt (Kernforschungszentrum, Karlsruhe, Germany). [1962]. 20p.

Indium foils were irradiated, and their activities were determined by a $4\pi\beta$-detector or a $4\pi\beta$-γ coincidence detector. The half lives of In^{116} and In^{116m1} were measured to be (14.10 ± 0.03 sec) and (54.12 ± 0.05 min), respectively. After a least-square fitting, the thermal activation cross sections for the 14-sec and 54-min In^{116} activities were 42 ± 1 and 160 ± 2b, while the absorption cross section was 202 ± 2b. The ratio σ^{14}/σ^{54} equaled 0.261 ± 0.008. The resonance activation integrals for the 54-min and 14-sec activities and the resonance absorption integral were 2480 ± 100, 680 ± 45, and 3160 ± 150b. The excess absorption and activation integrals were determined to be 3540 ± 150 and 2780 ± 120b. Additionally the ratio σ^{14}/σ^{54} of the activation cross sections for thermal and epithermal neutron activations were 0.267 ± 0.010 and 0.276 ± 0.015, respectively. The ratio of the resonance integral to the thermal activation cross section for the 54-min activity was 15.52 ± 0.50. (D.C.W.)

31402 (IITRI-A6027-3) STUDIES OF THE RESONANCE INTEGRALS OF Re AND Tm. Quarterly Progress Report, March 15, 1963 to June 30, 1963. G. Hardie, W. E. Loewe, and W. E. Zagotta (Illinois Inst. of Tech., Chicago. IIT Research Inst.). July 17, 1963. Contract AT(11-1)-579. 34p.

Progress is reported on the efforts to measure the infinitely dilute resonance integral of Tm by activation techniques, to investigate the sensitivity of IITRI reactor for danger coefficient measurements, and to calculate the effect of crystalline binding on the resonance integral of Re. The best available literature values for the beta decay branching ratio (i.e., the fractional number of times the first excited state of Yb^{170} is populated) and the internal conversion coefficient of the 84 kev transition in Yb^{170} were determined to be 0.22 ± 0.005 and 6.9 ± 0.5, respectively. A study of the gamma spectrum from the activated Tm showed that the errors in the photopeak intensity will not be of a major importance in the overall experimental accuracy. Preliminary calculations indicated that the RI_{Tm} is 1491 barns. Furthermore, if Au is used as a standard the measurements are relatively insensitive to possible deviations from a 1/E spectrum, because the main resonances in Au and Tm are at almost the same energy (3.92 ev and 4.95 ev respectively). The activity of nearly infinitely dilute Tm samples is satisfactory for good statistical accuracy in the foil counting. The IITRI reactor compares favorably with other reactors in terms of the reactivity effect of a resonance absorber sample, but suffers in the precision with which a reactivity effect can be measured. Although the ultimate sensitivity may not be as high as can be achieved in reactors designed for the purpose, it appears that a sensitivity of the order of 10^{-2} barns/nucleus for a one mole sample may be realizable with only relatively minor modifications. These include installation of a new flux level monitor with special instrumentation, a speed reducing gear box on one control rod, and an optical cathetometer for measuring rod position. (auth)

31403 (INSJ-56) NUMERICAL DIFFERENTIAL CROSS SECTIONS OF THE SCATTERING OF ALPHA PARTICLES. I. O^{16}. I. Nonaka, T. Mikumo, H. Yamaguchi, S. Hitaka, T. Maki, T. Nakashima, and M. Mukae (Tokyo Univ. Inst. for Nuclear Study). May 23, 1963. 28p.

Tables of cross sections for the elastic and inelastic scattering of alpha particles by O^{16} at various incident particle energies and scattering angles are included. The energy levels of O^{16} are also given. (D.C.W.)

31404 (INSJ-57) NUMERICAL DIFFERENTIAL CROSS SECTIONS OF THE SCATTERING OF ALPHA PARTICLES. I. N^{14}. I. Nonaka, T. Mikumo, H. Yamaguchi, S. Hitaka, T. Maki, T. Nakashima, and M. Mukae (Tokyo Univ. Inst. for Nuclear Study). May 23, 1963. 32p.

Cross sections for the elastic and inelastic scattering of alpha particles by nitrogen-14 at various incident alpha energies and angles are included. Energy levels of N^{14} are also given. (D.C.W.)

31405 (INSJ-58) CALCULATION OF THE EFFECT OF BETA VIBRATION ON THE COLLECTIVE LEVELS OF EVEN DEFORMED NUCLEI. Toshimitu Yamazaki (Tokyo Univ. Inst. for Nuclear Study). June 1, 1963. 17p.

Inclusion of beta vibration effects in the energy level calculations is discussed, and energies for the Bohr-Mottelson and Davydor-Filippor level schemes are included. (D.C.W.)

31406 (IS-695) MASS SYSTEMATICS INVOLVING LOW-LYING EXCITED STATES. F. Everling (Ames Lab., Ames, Iowa). [July 3, 1963]. Contract [W-7405-eng-42]. 16p. (CONF-52-1)

From 2nd International Conference on Nuclidic Masses, Vienna, July 1963.

A step phenomenon in the nuclidic mass excess surface associated with magic numbers N, Z = 8 and 20 is shown to exist, whereas only breaks occur at higher magic numbers. Excited states that reveal possible smooth trends within shell-model subshells are included. (auth)

31407 (JEN-120-DF/I-37) INTERACCIONES DE He^3 DE 29 Mev EN UN BLANCO DE Cl_4C. (Interaction of a 29-Mev He^3 Particle Beam with a Cl_4C Vapor Target). A. Lleo Morilla (Spain. Junta de Energia Nuclear, Madrid). 1963. 12p.

A CCl_4 vapor target was bombarded with 29-Mev He^3 particles. Differential cross sections for the elastic scattering and for the $C^{12}(He^3,\alpha)C^{11}$ pick-up reaction were obtained using photographic emulsion techniques. Angular distributions for the two processes were analyzed by the diffraction and optical model theories and by the Bulter method, respectively. The excitation energy of the first level of C^{12} proved to be 4.33 ± 0.25 Mev from the scattering. The first level of the residual C^{11} nucleus was established to be 1.94 ± 0.30 Mev from the pick-up reaction. (D.C.W.)

31408 (LADC-5821) FAST NEUTRON INDUCED FISSION OF U^{238} (thesis). Michael J. Bennett (New Mexico. Univ., Albuquerque). 1963. 64p.

An experimental study of the energetics of the fission of U^{238} performed with solid state detectors is described. The fissions were produced by fission-spectrum neutrons from a reactor. The procedure used for calibrating the detector response is described and the effects of some experimental uncertainties, such as pulse height defect and neutron emission, are discussed. The most probable light and heavy fragment energies were found to be, respectively, 98.3 ± 1.5 and 69.0 ± 1.5 Mev. The most probable masses were 98.4 ± 0.3 and 140.6 ± 0.3 mass units. The average total kinetic energy was 166.1 ± 2.0 Mev. No pronounced fine structure was seen on the mass yield curve. It appeared from this experiment that a simplified energy calibration procedure can be used in those cases where there exists time-of-flight information on the fission of the same or a neighboring nucleus. (auth)

31409 (NP-12965) NUCLEAR BREMSSTRAHLUNG. Technical Report No. 287. Walter Greiner (Maryland. Univ., College Park). Jan. 1963. 35p.

A formalism is developed in which the nuclear potential is explicitly worked into the radiation-matrix-elements. The result is an expansion of the ordinary matrix element in a power series of v/c and $\hbar\omega/\mu c^2$. In each term of this series the potential between the scattered particles occurs explicitly. With these expressions the bremsstrahlung of $n\text{-}He^4$-scattering is calculated if the nuclear potential is assumed to be a square well. Furthermore, the bremsstrahlung of n-p-scattering is studied for two kinds of interaction: square well and square well plus hard core. If the parameters of these potentials are chosen so that they give the same scattering length and effective range, there remains only a small difference in the bremsstrahlung cross section for the two types of potentials (some few percent). The shapes of the bremsstrahlung spectrum are equal in both cases. Some structure in the shape occurs at the virtual bound state of the s-wave. The magnitude of the bremsstrahlung cross section is of the order of 10^{-3} – 10^{-2} mb if the energy resolution is 0.2 Mev. It seems that nuclear bremsstrahlung can be measured. (auth)

31410 (TID-19051) ELASTIC SCATTERING POLARIZATION FOR 1.5-Mev NEUTRONS. R. J. Olness, K. K. Seth, and H. W. Lewis (Duke Univ., Durham, N. C.). [1962]. Contract [AT(40-1)-1067]. 20p.

The polarization produced in elastic scattering of 1.509-Mev neutrons from 18 medium-heavy and heavy nuclei was measured at a scattering angle of 51.5°. The $Li^7(p,n)Be^7$ reaction was used at an angle of 35° as a source of 26% polarized neutrons. A pulsed beam time-of-flight system was employed and a neutron-gamma ray discrimination circuit was used in conjunction with an organic liquid scintillator for neutron detection. The observed polarizations are found to vary smoothly with atomic weight. Comparison of the experimental results is made with the predictions of a square well complex potential model. It is concluded that an additional term proportional to neutron excess, $(N\text{-}Z)/A$, is required in the optical potential in order to fit the data for both medium-heavy and heavy nuclei. (auth)

31411 (UCRL-10747) ELECTRONIC AND NUCLEAR PROPERTIES OF Er^{171}, Tm^{171}, AND Tb^{161} (thesis). Isaac Maleh (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 29, 1963. Contract W-7405-eng-48. 75p.

The atomic-beam magnetic resonance flop-in technique was used to measure the angular momentum of the electrons and nuclei, electric and magnetic hyperfine interaction constants, and the magnetic moments of the electrons and nuclei. The nuclear magnetic moment and nuclear quadrupole moment were calculated from the Fermi-Segrè relation and from the $\langle 1/r^3 \rangle$ value by using other researchers' published values. All of these nuclei are in the collective model region and can be described by suitable Nilsson state assignments as indicated above. The quadrupole moment of Er^{171} yields a deformation of 0.238(20), which is low compared with those generally found in the rare-earth region; the nuclear magnetic moment of Er^{171} is less than collective-model predictions (perhaps due to uncertainty in g_R). Assuming a reasonable deformation factor for Tm^{171} the collective-model prediction for its nuclear magnetic moment agrees remarkably well with the measured value. The spin and resulting Nilsson state assignment for Tb^{161} agrees with that assumed from its decay scheme. A detailed description of the technique and a theoretical analysis of each result are presented. 40 references. (auth)

31412 (AEC-tr-5915) THE QUANTUM THEORY OF THE ATOMIC NUCLEUS. G. Gamow. Translated by J. J. Pinajian (Oak Ridge National Lab., Tenn.) from Z. Physik, 51: 204-12(1928). 12p.

An attempt is made to examine more closely the processes of α emission on the basis of wave mechanics and to

obtain theoretically the experimentally established relation between the decay constants and the energy of the α particle. (auth)

31413 (AEC-tr-5916) INTERFERENCE EFFECTS IN FISSION CROSS SECTIONS. PHASE ANALYSIS. (Interferentsionnye Effekty V Secheniyakh Deleniya. Fazovyĭ Analiz). I. V. Kirpichnikov, K. G. Ignat'ev, and S. I. Sukhoruchkin (Akademiya Nauk S.S.S.R. Institut Teoreticheskoĭ i Eksperimental'noi Fiziki). Translated by Lydia Venters (Argonne National Lab., Ill.). July 1963. 16p.

Low-energy fission and radiation cross-sections of U^{235} and Pu^{239}, previously measured with the pulsing cyclotron time-of-flight neutron spectrometer, were analyzed by means of multilevel approximation. The analysis was carried out in the energy region up to 8 ev for uranium and 20 ev for plutonium. Relative signs of the reduced width amplitudes and the degrees of interference were obtained for a number of the levels. Correlation in the signs of the amplitudes was found. The number of opened fission channels was found to be two for uranium and one for plutonium. Conclusions about relative spins of twelve levels of uranium and several levels of plutonium were made. Mean values of Γ_f were obtained for the levels with different spins. (auth)

31414 (AEC-tr-5917) MEASUREMENT OF η AND PARTIAL CROSS SECTIONS OF THE ISOTOPES U^{235} AND Pu^{239} FOR RESONANCE NEUTRONS. (Izmerenie η I Partsial'nye Secheniya Izotopov U^{235} I Pu^{239} Dlya Neitronov Rezonansnykh Energiĭ). K. G. Ignat'ev, I. V. Kirpichnikov, and S. I. Sukhoruchkin (Akademiya Nauk S.S.S.R. Institut Teoreticheskoĭ i Eksperimental'noi Fiziki). Translated by Lydia Venters (Argonne National Lab., Ill.). July 1963. 21p.

The energy dependence of η and total cross-sections of U^{235} and Pu^{239} have been measured for the resonance neutrons, using the pulsed cyclotron time-of-flight spectrometer with maximum resolution about 0.02 μsec/m (I). Fission and radiation cross-sections of these isotopes were obtained. The resolution of the spectrometer was high enough to obtain the parameters of 26 levels of the uranium and 23 levels of the plutonium. (auth)

31415 THE α-RADIOACTIVE DECAY IN THE SEMICLASSICAL APPROXIMATION. A. N. Weiszmann and I. Stan. Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn., 12: 339-46(1961). (In Rumanian)

Problems presented by the spontaneous α decay of the isotopes of some medium and light elements are reviewed. The whole range of α-active isotopes was examined within the framework of a higher-order, semiclassical approximation, making use of previous derivations in this field. The calculations are based on G. Gamow's semiclassical theory (Z. Physik 51: 204-12(1929)), used as basis of the study. The nucleus of the α-active isotope is considered a quantum system of two spheroid bodies, the emitting nuclide and the particle emitted. The considerations are valid only in the Coulomb region, where $r > R + R_\alpha$, being the distance between the spheres. Thus, the problem of the interaction of the two bodies is reduced to that of the interaction of a low-mass particle with a central potential field. The formula derived allows the radioactive constants of α-active isotopes of both light and medium elements to be calculated, which was not possible previously; Gamow's considerations are valid only for heavy elements, yielding large errors in the other fields. Specific examples are given for certain isotopes, such as Dy^{152}, Tb^{149}, Cl^{32}, Al^{24}, and Na^{20}. Calculation of the half lives of B^8 and Be^8 yielded better values than calculations carried out on the basis of Russell potentials. (TTT)

31416 NEW INVESTIGATIONS ON THE NUCLEAR MATTER AND ITS PROPERTIES. Margareta Ignat. Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn., 13: 65-79(1962). (In Rumanian)

In order to find the stationary state of the nucleus, the multibody problem must be solved. The nuclear shell model is able to explain satisfactorily many properties of the nucleus by assuming that each nucleon is able to move freely in a potential with spherical symmetry, each nucleon orbit being characterized by quantum numbers. The validity of the shell model appears to be paradoxical because it involves large forces with a short radius of activity. Bogolyubov introduced an analogy between the nuclear structure and the electronic structure of a superconducting metal, attributing superfluidity properties to the nuclear matter, which is viewed as a Fermi gas of freely moving neutrons and protons. The independent-particle and pair models are reviewed on the basis of the Bethe-Goldstone eigenfunctions. The total energy of the nuclear matter may be calculated from the Bethe-Goldstone wave function, interpreting the values obtained as density and bond energy of the nuclear matter. The superfluidity model made it possible to explain the existence of an energy gap in the case of even-even nuclei, between the first excited state and the ground state; it was also found useful for clarifying the moments of inertia of heavy nuclei which are much smaller than they would be if the nucleus would rotate as a solid body. (TTT)

31417 PAIS APPROXIMATE FORMULA FOR THE PHASE SHIFT AND ELECTRON SCATTERING IN THE THOMAS-FERMI THEORY. T. Tietz (Univ. of Lodz, Poland). Acta Phys. Acad. Sci. Hung., 16: 1-6(1963). (In English)

The phase shifts are calculated by means of a simplified Pais method for the Thomas-Fermi and analytical Hartree potentials. The calculation presented shows that the method gives more accurate results for the phase shifts than the Born approximation, having the advantage that it is much more practical than the Pais method. (auth)

31418 GROUND-STATE EQUILIBRIUM DEFORMATIONS OF NONSTABLE NUCLEI IN THE TRANSURANIC REGION. Z. Szymański (Inst. for Nuclear Research, Warsaw). Acta Phys. Polon., 23: 543-51(Mar. 1963). (In English)

Previous calculations of the equilibrium quadrupole moments and deformations in the transuranic region are extended to the whole region of unstable nuclei with $84 \leq Z \leq 100$ and $130 \leq N \leq 152$. (auth)

31419 GAMMA-GAMMA DIRECTIONAL CORRELATIONS OF Ce^{140}. L. Simons (Univ. of Helsinki), K.-E. Nystén, P. Holmberg, H. Jungner, A. Anttila, S. Bergstroem, and E. Hageboe. Acta Polytech. Scand., Phys. Nucl. Ser., No. 22, 1-35(1963). (In English)

The excited levels in Ce^{140} were investigated by studying the decay of La^{140}. Intensities were determined from gamma-ray spectra and the results are 328 kev (19%), 435 kev (0.4%), 490 kev (44%), 635 kev (<1%), 753 kev (5%), 818 kev (22%), 874 kev (5%), 927 kev (9.5%), 1120 kev (1%), 1597 kev (100%), 1680 kev (1%), 2355 kev (0.5%), 2530 kev (4%), 2900 kev (0.15%), and 3100 kev ($\ll$ 1%). Weak peaks were found at 120, 135, 178, 240, and 270 kev; the intensities were less than 2%. From the results of gamma-ray, coincidence and sum spectra a level scheme

for Ce^{140} is proposed. Angular correlation measurements of eight cascades were carried out and they gave the following spin sequences: 1597 kev, 2^+; 1902 kev, 0^+; 2090 kev, 4^+; 2350 kev, 1^+ or 2^+; 2410 kev, 3^+; 2530 kev, 2^+; 3280 kev, 2 or 4, and 3390 kev, 0 or 2. (auth)

31420 ON THE TRANSITIONS FROM THE EXCITED LEVELS OF Re^{187}. K. S. Han, S. C. Pancholi, and Y. Grunditz (Uppsala Univ.). Arkiv Fysik, 23: 505-13(1963). (In English)

The internal conversion spectrum from the excited levels of Re^{187} was studied by means of a high resolution double focusing magnetic beta-ray spectrometer. A total of 34 internal conversion lines and six Auger lines were found. The energies of the 14 observed gamma transitions are in excellent agreement with those of previous work. Multipolarity assignments for the gamma-transitions were made on the basis of internal conversion coefficient ratios. (auth)

31421 A COMPARISON OF THE SEMI-CLASSICAL APPROXIMATION AND THE EXACT SOLUTION OF THE OPTICAL MODEL SCATTERING PROBLEM. T. A. Eriksson and G. A. Rinander (Uppsala Univ.). Arkiv Fysik, 24: 1-15(1963).

Two methods for solving the particle-nucleus elastic scattering problem are compared. Numerical results of the Schroedinger equation are compared with an approximate method valid at high energies, which is the semi-classical approximation. The Coulomb potential due to a homogeneously charged sphere was used. The calculations were made for incident nucleon energies of 20, 40, 90, and 180 Mev. Comparisons were made between the elastic differential cross section and nucleon polarizations derived by both methods. The nucleus was assumed to be spherical and to have nuclear spin zero. (C.E.S.)

31422 AN INVESTIGATION OF THE GAMMA-RAY DECAY FROM FIVE RESONANCES IN THE REACTION $Sc^{45}(p,\gamma)Ti^{46}$. Bengt Erlandsson and Kalevi Valli (Univ. of Lund, Sweden). Arkiv Fysik, 24: 31-48(1963). (In English)

Targets of Sc^{45} were bombarded with protons at energies from 1.3 to 2.5 Mev. The gamma-ray yield was measured as function of the proton energy. The maxima that were observed in the yield curve correspond to excited states in the compound nucleus Ti^{46} corresponding to the 1.380, 1.550, 1.660, 1.960, and 2.060-Mev resonances. The decay schemes of these levels were investigated with a three crystal spectrometer and gamma–gamma coincidence techniques. Five new levels in the lower region of the decay scheme were found. (auth)

31423 GAMMA–GAMMA ANGULAR CORRELATION AND INTENSITY MEASUREMENTS ON LOW ENERGY GAMMA RAYS IN THE DECAY OF Ce^{144}. W. Zuk and S. Gustafsson (Inst. of Physics, Uppsala). Arkiv Fysik, 24: 69-77(1963). (In English)

The decay of Ce^{144} was investigated using a gamma scintillation spectrometer and an automatic gamma–gamma directional correlation apparatus. The relative intensities of the gamma rays of Pr^{144}, 134 and 80 kev, and the 36 kev x ray were measured giving the following result 100: 33.4 ± 1.0: 107.0 ± 2.0. The result for the 80 kev gamma ray is in agreement with Hickok et al., and in disagreement with Geiger et al. A measurement was done of the gamma–gamma angular correlation of the 54–80 kev cascade in Pr^{144}. The measurement confirms the 1-spin assignment for the 134 kev level. In Nd^{144} was measured the angular correlation of the 1.49–0.69 Mev cascade. The result is in very good agreement with the previous measurements. (auth)

31424 GAMMA RAY COINCIDENCE STUDIES ON THE DECAY OF Dy^{165}. Lars Persson (Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 24: 89-96(1963). (In English)

An investigation is performed of the gamma ray coincidence relations in the decay of Dy^{165} to Ho^{165}. The 621 kev gamma ray was observed to be in coincidence with the 95 and 280 kev transitions, confirming the existence of the suggested level at 716 kev. The 1056 and 1080 kev gamma rays were found to de-excite levels of the corresponding energies in Ho^{165}. An upper limit is obtained for the intensity of the gamma rays depopulating the 995, 1056, and 1080 kev levels to the 95 kev rotational state. The de-excitation of these levels is also examined using a sum coincidence technique. The nuclear level scheme of Ho^{165}, based on the recent studies on the decays of Dy^{165} and Er^{165} and on the Coulomb excitation of Ho^{165}, is discussed in the view of the results of the measurements. (auth)

31425 NUCLEAR LEVEL SPLITTING CAUSED BY A COMBINED MAGNETIC DIPOLE AND NON-AXIALLY SYMMETRIC ELECTRIC QUADRUPOLE INTERACTION. Eckart Matthias (Uppsala Univ.), Werner Schneider, and Rolf M. Steffen. Arkiv Fysik, 24: 97-111(1963). (In English)

A previous theoretical investigation of the nuclear level splitting for a static mixed magnetic dipole and electric quadrupole interaction was extended to the case of an electric field gradient that does not possess axial symmetry. The energy eigenvalues that depend on the parameters y, η, β, and α were obtained by numerical diagonalization of the interaction hamiltonian. The results are displayed in several figures, where the dependence of the energy levels on the different parameters y, η, β, and α is shown. The parameter $y = \omega_H/\omega_E$ is the ratio between the magnetic interaction frequency ω_H and the fundamental electric quadrupole interaction frequency ω_E. The asymmetry parameter $\eta = (V'_{x'x'} - V'_{y'y'})/V'_{z'z'}$ describes the deviation of the electric field gradient ($V'_{x'x'}$, $V'_{y'y'}$, $V'_{z'z'}$) from axial symmetry. The angle β is the angle between the magnetic field and the z′ principal axis of the electrostatic gradient tensor ($|V'_{z'z'}| \geq |V'_{y'y'}| \geq |V'_{x'x'}|$). The angle α describes the relative position of the x′ principal axis of the electrostatic gradient tensor with respect to the plane defined by the magnetic field direction and the z′ axis of the electrostatic gradient tensor. (auth)

31426 RADIATIVE PROTON CAPTURE IN Sc^{45}. J. Dubois and S. Maripuu (Chalmers Univ. of Tech., Goteborg). Arkiv Fysik, 24: 127-49(1963). (In English)

The reaction $Sc^{45}(p,\gamma)Ti^{46}$ was studied for proton energies in the range 900 to 1400 kev. 134 resonances were found. The capture gammas were studied at 10 resonances. The low energy levels observed in Ti^{46} are in good agreement with levels obtained from inelastic scattering and beta-decay measurements. New levels were found at 3.29 ± 0.02, 3.60 ± 0.05, and 3.69 ± 0.05 Mev. The gamma-ray branching ratios for the low-lying levels up to 3.69 Mev were measured. (auth)

31427 DETERMINATION OF THE ELECTROMAGNETIC TRANSITION PROBABILITIES IN THE GROUND STATE DECAY OF Au 199. J. Lindskog, T. Sundstroem, J. O. Lindstroem, and P. Sparrman (Uppsala Univ.). Arkiv Fysik, 24: 161-9(1963). (In English)

The lifetimes of the two levels in Hg 199 that are fed from Au 199 were measured by the delayed coincidence technique. The result is: 158 kev level: $T_{1/2}$ = (2.42 ± 0.15) ns. 208 kev level: $T_{1/2}$ = (66 ± 6) ps. The decay of

As 199 is discussed in terms of the core excitation model. The result of the measurements is found to be consistent with the predictions of this model. (auth)

31428 INFLUENCE OF A COMBINED MAGNETIC DIPOLE AND NON-AXIALLY SYMMETRIC ELECTRIC QUADRUPOLE INTERACTION ON ANGULAR CORRELATIONS. Eckart Matthias, Bengt Olsen, and Werner Schneider. Arkiv Fysik, 24: 245-55(1963). (In English)

A previous theoretical investigation of the influence of a combined magnetic dipole and electric quadrupole perturbation on angular correlations was extended to the case of a non-axially symmetric electric field gradient. Explicit calculations of the real parts of the differential and integral attenuation coefficients were performed for the two spin values I = 2 and $5/2$. It is shown that the integral correlation is not appreciably affected by an asymmetry of the electric field gradient. The influence of an asymmetry may, however, be measurable with differential correlations if suitable magnetic field strengths are applied. (auth)

31429 SEARCH FOR AN ISOMERIC SHIFT IN THE $K\alpha_1$ X-RAY OF Tm^{169}. P. Bergvall, B. Lindstroem, and E. N. Hatch (Johns Hopkins Univ., Baltimore). Arkiv Fysik, 24: 257-83(1963). (In English)

About half of the Tm Kα x rays emitted following the electron-capture decay of Yb^{169} are emitted with the Tm^{169} nuclei in either the 473 or 379-kev excited isomeric states. Since the nuclear charge distribution of the Tm^{169} nuclei in these two excited isomeric states is expected to be different from the nuclear charge distribution of the Tm^{169} nuclei in the ground state, a slight isomeric shift of the Kα x rays is expected. A search for this isomeric shift of the Tm $K\alpha_1$ x ray was carried out by means of a 2-meter curved-crystal spectrometer. No isomeric shift within the resolving power of the spectrometer could be observed. The result for the measured shift of the energy of the Tm $K\alpha_1$ x ray emitted from an Yb^{169} source compared with the energy of the $K\alpha_1$ x ray emitted from a Tm x ray source with all Tm^{169} nuclei in the ground state was 0.07 ± 0.7 ev. Thus an upper limit of 0.8 ev for the observed shift in energy of the Tm $K\alpha_1$ x ray emitted by an Yb^{169} source compared with the energy of the Tm $K\alpha_1$ x ray emitted by a natural Tm x-ray source can be set. Since somewhat less than one half of the $K\alpha_1$ x rays emitted from the Yb^{169} source are emitted with the Tm^{169} nuclei in the 473 or 379-kev excited isomeric states, an experimental upper limit of 1.8 ev for the actual isomeric shift of the Tm $K\alpha_1$ x ray can be set from this measurement. In addition, the wavelength of the Tm $K\alpha_1$ x ray emitted from an Yb^{169} source was measured to be 243.829 ± 0.006 XU, which is in good agreement with the previous measurement by Bergvall. (auth)

31430 THE ANGULAR DISTRIBUTION OF 1.79 Mev NEUTRONS SCATTERED FROM HELIUM. P. G. Young (Australian National Univ., Canberra), G. G. Ohlsen, and P. L. Okhuysen. Australian J. Phys., 16: 185-92(June 1963).

The angular distribution of 1.79 ± 0.05 Mev neutrons scattered from He^4 was measured in an effort to settle a discrepancy in the phase shifts. The laboratory angular range 25 to 135° was covered. The results are compared with differential cross sections computed from the phase shifts of Dodder and Gammel and Demanins et al., and the data are seen to agree best with the former. (auth)

31431 A STUDY OF THE $Be^9(He^3,n)C^{11}$ REACTION. L. Van der Zwan (Dalhousie Univ., Halifax, Nova Scotia), A. T. Stewart, J. Y. Park, and E. Merzbacher. Can. J. Phys., 41: 1036-46(July 1963).

The energy spectra and angular distributions of the emergent neutrons from the $Be^9(He^3,n)C^{11}$ reaction are obtained for an incident particle energy of 2 Mev, with the technique of observing proton recoil in photographic emulsions. The cross sections are normalized to $Be^9(He^3,p)B^{11}$ data observed simultaneously at 90° to the beam. The lack of similarity in the (He^3,n) and (He^3,p) mirror reactions to some residual states suggests a direct interaction mechanism rather than compound nucleus. An attempt to analyze some of the data in terms of double particle stripping is made. (auth)

31432 MEASUREMENT OF THE POLARIZING POWER OF COPPER AND ZIRCONIUM FOR 3.4-Mev NEUTRONS. J. Durisch, R. Gleyvod, P. Huber, and E. Baumgartner (Universität, Basel). Helv. Phys. Acta, 36: 269-86(1963). (In German)

The azimuthal asymmetry of (d,d) neutrons scattered by copper and zirconium was measured at six different angles. A thick heavy ice target was bombarded with deuterons of 800 kev energy (mean neutron energy 3.16 Mev). The asymmetry was measured with fixed counter-position by rotating the polarization of the incident neutron beam through an angle of ± 90° by means of a solenoid. The analyzing power of copper and zirconium was determined at lab. scattering angles of 55 to 120°. The values of the analyzing power were corrected for multiple scattering and the polarization of the d,d neutrons was assumed to be $P_i = -0.10$. (auth)

31433 MEASUREMENT OF THE POLARIZING POWER OF OXYGEN FOR d,d-NEUTRONS AT ENERGIES OF 2.5 TO 3.2 Mev. R. Gleyvod, J. Durisch, P. Huber, and E. Baumgartner (Universität, Basel). Helv. Phys. Acta, 36: 287-97(1963). (In German)

The azimuthal asymmetry of d,d neutrons elastically scattered by oxygen-16 was measured at three different scattering angles. A thick heavy ice target was bombarded with deuterons of 350 and 550 kev energy (mean neutron energy 2.84 and 2.98 Mev respectively). The asymmetry was measured with fixed counter position by rotating the polarization of the incident neutron beam through an angle of ± 90° by means of a solenoid. The determined analyzing power of oxygen at scattering angles (center-of-mass system) of 57 to 109° are measured. All phaseshift sets derived from total and differential scattering cross sections do not fit these results. (auth)

31434 (n,t) REACTIONS ON MEDIUM NUCLEI. F. Heinrich and F. Tanner. Helv. Phys. Acta, 36: 298-316(1963). (In German)

Measurements are made on the total cross sections for the capture of fast neutrons, inducing triton emission, in medium nuclei. The method employed allows the determination of the absolute quantity of tritium produced. The (n,t) cross sections on Al, Cr, Mn, Fe, Co, Ni, and Cu agree with the results of the statistical theory of nuclei. However, in the case of silver, the reaction probability is a factor of 40 larger than that expected from the concept of the compound nucleus, which discrepancy can possibly be interpreted as being produced by a direct interaction. Because of the large amount of tritium produced by the reaction $Li^6(n,\alpha)H^3$, a method is developed to indicate traces of impurities of lithium in the target materials. (auth)

31435 STUDY ON BACKSCATTERED γ-RAY. Masaya Nakata. Hi-hakai Kensa, 10: 263-8(Nov.-Dec. 1961).

The backscattered γ ray considered to cause radiographi-

cal fogginess was studied by means of Co^{60} and Cs^{137} sources. Lead, iron, concrete, and wood were used as the scattering materials. The scatterer thickness (considered to be infinite), its area related to backscattering, the effect of distance from the source, and its energy spectrum were measured. It was observed that the backscattered γ ray from Pb consists mostly of its characteristic x ray and Compton singly-scattered photons; and that from concrete is rich in multi-scattered photons. The quantity of the backscattered rays from concrete was greater than that from Pb. The effect of a Pb plate covering a concrete block studied indicated a great decrease of the multi-scattered photons from the concrete block and can be expressed by a simple formula. The dosage rate can be cut down to half when a model room is covered with 1.0 mm thick Pb plate. (OID)

31436 THE CROSS SECTION OF THE $Li^7(n,t)$ REACTION FOR NEUTRON ENERGIES BETWEEN 3.5 AND 15 Mev. F. Brown, R. H. James, J. L. Perkin, and J. Barry (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. A & B, 17: 137-41(June 1963). (In English)

The $Li^7(n,t)$ reaction cross section is measured for energies between 3.5 and 15 Mev, using an activation method involving the extraction and counting of residual tritium. The cross section is found to increase sharply from an effective threshold of 4 Mev to the value of approximately 360 mb at 6 Mev, remaining constant at this value up to the highest energy measured. (auth)

31437 INTERPRETATION OF THE EXCITED-STATE SCHEME OF THE ODD-ODD NUCLEUS Pa^{234}. Roger Foucher, Jean Mérinis, Alcue de Pinho, and Manuel Valadarés (Centre de Spectroscopie Nucléaire et de Spectroscopie de Masse, Orsay, France). J. Phys., 24: 203-5 (Mar. 1963). (In French)

Characteristics of excited levels found in Pa^{234} are discussed and compared with theoretical predictions. (auth)

31438 (d,α) REACTIONS ON C^{12} AND O^{16} WITH DEUTERONS IN THE ENERGY RANGE FROM 15 Mev TO 20 Mev. Takuji Yanabu, Sukeaki Yamashita, Teruo Nakamura, Kunio Takamatsu, Akira Masaike, Shigeru Kakigi, Dai Ca Nguyen, and Kiyohiko Takimoto (Kyoto Univ.). J. Phys. Soc. Japan, 18: 747-57(June 1963).

Angular distributions and total cross sections of the $C^{12}(d,\alpha)B^{10}$ and $O^{16}(d,\alpha)N^{14}$ reactions were obtained in the deuteron energy range from 15 to 20 Mev. Alpha particle groups leaving the residual nuclei in their low-lying states showed pronounced forward and backward peaks simultaneously in the whole energy range. Total cross sections decreased gradually with increasing deuteron energies, but some anomalies were found. Reaction mechanisms are discussed under the assumptions of knock-out and heavy-particle stripping processes, and it is indicated that the clustering of nucleons at the surface of the target and or the residual nuclei seems to play an important role in these reactions. (auth)

31439 RADIOCHEMICAL STUDIES ON URANIUM MULTIPLE FISSION. 4. FISSION YIELD OF Cu^{67}. R. Muenze and O. Hladik (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 225-8(May 1963). (In German)

Uranium with various U^{235} contents was irradiated with neutrons, and the copper activity was separated from the fission products. After decay of the Cu^{64} activity which could be limited by the small copper content of the sample, the Cu^{67} could be detected and measured. (tr-auth)

31440 THE REACTION $Ne^{20}(\alpha,C^{12})C^{12}$. N. O. Lassen and Janus Staun Olsen. Kgl. Danske Videnskab. Selskab, Mat. Fys. Medd., 33: No. 13, 1-20(1963). (In English)

Natural neon was bombarded by α-particles with laboratory energies ranging from 12 to 20 Mev. The neon gas serving as target was used at the same time as filling gas for a gridded, electron collection type ionization chamber used to measure the emitted carbon ions. The differential cross section at C.M. angle 90° was measured as a function of energy; the excitation curve shows several peaks. The angular distributions were measured for each of these peaks. One distribution follows a $[P_3(\cos\theta)]^2$ curve; this peak may correspond to a single 8 + state in the compound Mg^{24} nucleus at 25.2 Mev excitation energy, having $\Gamma <$ 150 kev. The other angular distributions also show strong maxima and minima, but at least two even angular momentum states must contribute to each peak. It is believed that a somewhat larger number of states participate in the reaction, statistical variations in this number being responsible for the appearance of the excitation curve. (auth)

31441 RELATIONSHIP BETWEEN THE CROSS-SECTIONS OF NEUTRON REACTIONS AND THE ACTIVITIES OF REACTION PRODUCTS WHEN ACTIVATED BY FLUXES VARYING IN TIME. József Bacsó and Sándor Daróczy. Magy. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 5: 17-23(May 1963). (In Hungarian)

Relationships are given between the cross sections of neutron reactions and the activities of the radioactive products. The relationships apply to activations carried out by means of fluxes varying in time (accelerators and sources decomposing exponentially). (auth)

31442 NUCLEAR-CHEMICAL SIGNIFICANCE OF ABSOLUTE RADIOACTIVITY MEASUREMENTS. PART 1. DETERMINATION OF THE DECOMPOSITION HALF-TIME OF THE Pb-210(RaD) NUCLIDE. Lajos Imre, Gyula Fabry, and Istvan Dezsi (Kossuth Lajos Scientific Univ., Debrecen, Hungary). Magy. Tud. Akad., Kem. Tud. Oszt. Kozlemen., 19: 1-24(1963).

A method was developed for the determination of the decomposition constant of the RaD (Pb^{210}) nuclide by means of absolute radiation particle counting. It was found that the decomposition half life is 22.85 yr. By knowing this figure, it is possible to prepare accurate RaD + E measurement standards without the need of using particle counters. (OTS)

31443 μ^- CAPTURE IN He^4. C. A. Caine and P. S. H. Jones (Clarendon Lab., Oxford). Nucl. Phys., 44: 177-86 (June 1963). (In English)

The total capture rate is calculated by summing explicitly over the possible final states, previous calculations having used a closure approximation to perform this summation. In addition, by means of a more general closure argument, a recent experimental value for the capture rate is shown to be incompatible with the capture interaction of Fujii and Primakoff and the generally accepted features of the He^4 ground state wave function. (auth)

31444 MECHANISM OF THE $Li^7(p,\alpha)He^4$ REACTION. N. Sarma, K. S. Jayaraman, and C. K. Kumar (Atomic Energy Establishment, Trombay, India). Nucl. Phys., 44: 205-11(June 1963). (In English)

The reaction $Li^7(p,\alpha)He^4$ was investigated to determine the contribution of direct interaction processes to the cross section. Excitation functions at angles θ_{cm} = 60, 80, 100 and 150 degrees and the angular distributions at incident energies E_p = 3.0, 3.5, 4.0, 4.5, 4.88, 5.0, and 5.5 Mev were measured. Resonant processes predominate in the

reaction, and an analysis was made to determine the spins of the compound-nucleus states in Be^8 at 19.9 and 22.2 Mev. (auth)

31445 CONVERSION-GAMMA ANGULAR CORRELATION MEASUREMENTS IN Gd^{152} POPULATED BY THE BETA DECAY OF Eu^{152}. J. Burde, A. Catz, and S. Palti (Hebrew Univ., Jerusalem). Nucl. Phys., 44: 212-19(June 1963). (In English)

Angular correlation measurements were carried out between the K conversion electrons of the 344 kev transition and the gamma particles de-exciting all the upper levels in Gd^{152} populated by the 13-yr Eu^{152} disintegration. The coincidence gamma spectrum was recorded simultaneously on a multichannel pulse-height analyzer at the angles 270, 180, and 90°, where the information was accumulated for 4 cascades. The anisotropies derived from the present measurements combined with the data of the conversion coefficients yielded the spin assignment 2^+, 3^-, and 2^- for the levels 755 kev, 1124 kev, and 1614 kev, respectively. The 2^+, 755-kev level together with the 615 kev, 0^+ state comprise two members of the two phonon vibration excitation triplet. Some evidence is obtained for a weak γ-ray around 500 kev, and it is suggested that perhaps this is the 4^+ missing member of the triplet. A tentative 3^- spin assignment for 1444 kev level, on the basis of the present anisotropy measurement and the β feeding to the level, is also proposed. (auth)

31446 LIFETIMES OF THE LOW-LYING LEVELS OF O^{18} AND F^{18}. A. E. Litherland, M. J. L. Yates, B. M. Hinds, and D. Eccleshall (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Phys., 44: 220-55 (June 1963). (In English)

The lifetimes or limits on the lifetimes of five levels in O^{18} and six levels in F^{18} were measured by the Doppler shift attenuation method. Large initial Doppler shifts for the gamma rays from O^{18} and F^{18} were obtained by bombarding tritium with 11 to 16-Mev oxygen ions from a tandem accelerator. The mean lifetimes in psec of the 1.98, 3.55, 3.63, 3.92, and 4.45-Mev levels in O^{18} were found to be 3.7 ± 0.7, >3, 3 ± 1, 0.18 ± 0.06 and <0.1, respectively. The mean lifetimes in psec of the 0.94, 1.04, 1.08, 1.70, 2.10 and 2.53-Mev levels in F^{18} were found to be >3, <0.3, >1.0, 2.0 ± 1.0, 0.70 ± 0.20, 1.1 ± 0.2, respectively. The significance of these measurements is discussed. (auth)

31447 INELASTIC NEUTRON SCATTERING IN Pb^{208}. J. H. Towle and W. B. Gilboy (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 44: 256-67(June 1963). (In English)

Inelastic scattering by Pb^{208} was studied with neutrons of energy up to 4.5 Mev, using the time-of-flight technique. Spectra due to practically pure Pb^{208} were obtained by subtracting those obtained with a sample containing 71% Pb^{208} and a suitable smaller sample of radiogenic Pb. Neutron groups denoting excitations in Pb^{208} of 2.61 ± 0.02, 3.20 ± 0.02, and 3.48 ± 0.02 Mev were observed, which correspond to the positions of known levels. Cross sections for the excitation of these levels were measured at several energies. No evidence was obtained for any other levels below 3.5 Mev, and upper limits have been placed on the cross sections for the possible excitation of other previously suggested levels. The inelastic cross sections were compared with preliminary theoretical predictions based on nuclear potentials of local and non-local types, and the implications of these comparisons are discussed. (auth)

31448 THE ELECTRON CAPTURE RATIO AND THE CONVERSION COEFFICIENT OF THE 14.4 kev GAMMA RAY IN THE DECAY OF ^{57}Co. H. C. Thomas, C. F. Griffin, W. E. Phillips, and E. C. Davis, Jr. (Texas Technological Coll., Lubbock, Tex.). Nucl. Phys., 44: 268-74 (June 1963). (In English)

A proportional counter and a thin window scintillation counter were used to investigate the low energy electromagnetic radiations in the decay of Co^{57}. The value found for the internal conversion coefficient of the 14.4-kev gamma ray is 9.94 ± 0.60 and for the electron capture ratio is 0.118 ± 0.014. (auth)

31449 INELASTIC SCATTERING FROM SOME RARE-EARTH ISOTOPES OF LOW ABUNDANCE. J. Bjerregard, B. Elbek, O. Hansen, and P. Salling (Universitet, Copenhagen). Nucl. Phys., 44: 280-6(June 1963). (In English)

The reduced E2 transition probability and the excitation energy of the first rotational level in the isotopes of Nd^{150}, Dy^{156}, Dy^{158}, Er^{162}, Yb^{168} and Hf^{174} were measured by means of Coulomb excitation. The measurements were performed on the inelastically scattered protons or deuterons, which were recorded in a heavy-particle spectrograph. The results are discussed in terms of the rotational model, and the ground-state deformations derived from experiment are compared to the calculations of Bès and Szymański. The rotational character of the first 2^+ levels in the four stable N = 90 nuclei is briefly discussed in the light of recent data from other experiments. (auth)

31450 THE GAMMA DECAY OF THE 10.22-Mev STATE IN N^{14}. H. J. Rose, W. Trost, and F. Riess (Universität, Freiburg i. B.). Nucl. Phys., 44: 287-93(June 1963). (In English)

The gamma ray spectrum due to the decay of the 10.22-Mev excited state in N^{14} was investigated using the reaction $C^{13}(p,\gamma)N^{14}$ at a proton bombarding energy $E_p = 2.88$ Mev and applying three crystal pair spectrometer techniques. The most prominent transition from this state was found to lead to the $J^\pi = 0^+$, 2.31-Mev first excited state. The cross section for this transition was determined to be (36 ± 8) μb (using 700 μb for the $E_p = 3.11$ Mev resonance). The total width of the state was determined to be 85 ± 15 kev and the resonance was located at $E_p = 2.885 \pm 0.010$ Mev. The gamma width of the 10.22 → 2.31 transition is determined to be $(2J + 1)\Gamma_\gamma = 12 \pm 4$ ev which excludes $J^\pi = 2^-$. From the angular distribution of the 10.22 → 2.31 transition the assignments $J^\pi = 2^+$ and 1^- are excluded and an assignment $J^\pi = 1^+$ is given to the 10.22-Mev state assuming the 10.22-Mev state to be a well-isolated single level with respect to the decay to the 2.31-Mev state. The strength $|M(M1)|^2$ of the 10.22 → 2.31 M1-transition supports a T = 0 assignment for the 10.22-Mev state. Furthermore, several gamma rays due to the direct radiative capture of a proton into the presumably $p_{\frac{1}{2}} s_{\frac{1}{2}}$ and $p_{\frac{1}{2}} d_{\frac{5}{2}}$ states in N^{14} were observed. (auth)

31451 ON THE COLLECTIVE STATES OF C^{12} AND GROUND-STATE CORRELATION. A. Goswami (Saha Inst. of Nuclear Physics, Calcutta) and M. K. Pal. Nucl. Phys., 44: 294-308(June 1963). (In English)

The collective electric dipole, quadrupole and octupole states of C^{12} were calculated, including the effects of ground state correlation, by the Sawada method and using finite range Soper force. A first order calculation of the amount of ground state correlation indicates that this amount is considerable in C^{12} and that most of it is due to quadrupole vibrations. The justification of the Sawada method for C^{12} is discussed in this context. Quantities related to the

ground state correlation that can be determined experimentally are also calculated and discussed. (auth)

31452 THE MECHANISM OF THE REACTION $Se^{76}(d,p)Se^{77}$. B. E. F. Macefield (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.), R. Middleton, and D. J. Pullen. Nucl. Phys., 44: 309-19(June 1963). (In English)

Angular distributions of seventeen proton groups from the $Se^{76}(d,p)Se^{77}$ reaction at an incident deuteron energy of 7.8 Mev were measured. Optical model parameters were extracted from elastic scattering measurements and are compared with those required by D.W.B.A. calculations to give best agreement with the observed angular distributions. Some evidence is presented that indicates that spin dependent optical model forces are needed to explain the experimental observations. (auth)

31453 DECAY OF Cd^{115}(2.3d). H. S. Hans and G. N. Rao (Muslim Univ., Aligarh, India). Nucl. Phys., 44: 320-8 (June 1963). (In English)

The decay of Cd^{115} (2.3d) was studied by scintillation beta and gamma spectroscopy. The K-internal conversion coefficients of the 35 and 335 kev gamma transitions in the de-excitation of In^{115} were measured to be 7.6 ± 0.8 and 0.84 ± 0.09, respectively. The β-γ coincidences showed that the 590 and 860 kev beta branchings may be of an allowed and $\Delta I = 2$ unique forbidden types, respectively. From the angular correlation studies of the 35–492 kev and 230–262 kev cascades, $5/2^-$, $3/2^-$ and $1/2^-$ or $3/2^-$ may be assigned to the 597, 827 and 862 kev levels, respectively. (auth)

31454 THE $Al^{27}(p,\alpha)Mg^{24}$ REACTION WITH 3 TO 12 Mev PROTONS. K. L. Warsh, G. M. Temmer, and H. R. Blieden (Florida State Univ., Tallahassee). Nucl. Phys., 44: 329-37(June 1963). (In English)

Excitation curves and angular distributions of alpha-particle groups from the reaction $Al^{27}(p,\alpha)Mg^{24}$ were determined between 3 and 12 Mev proton energy. Most of the results bear on the ground-state and first-excited state transitions; a few angular distributions between 10 and 12 Mev for higher excited states are included. (auth)

31455 RADIATIVE CAPTURE ABOVE THE GIANT RESONANCE IN C^{12}. N. W. Reay (Univ. of Minnesota, Minneapolis), Norton M. Hintz, and L. L. Lee, Jr. Nucl. Phys., 44: 338-52(June 1963). (In English)

Excitation functions for the radiative capture reaction, $B^{11}(p,\gamma)C^{12}$, to the ground and first excited states of C^{12} were measured in the region above the giant resonance (E_p = 15 to 25 Mev). A component of the dipole state, predicted at an excitation energy of 34.3 Mev in C^{12} by the particle-hole calculations of Vinh-Mau and Brown, was found at an energy of 34.4 ± 0.5 Mev. However, the ratio of proton capture at the 34.4 Mev state to that at the main dipole component at 22 Mev is an order of magnitude less than that implied by the Vinh-Mau and Brown model. Some data were obtained for the reaction $Li^7(p,\gamma)Be^8$. Both experiments suggest giant dipole resonances built on the first excited states of Be^8 and C^{12}. (auth)

31456 LOWER EXCITED STATES IN Os^{188} AND Os^{190} INVESTIGATED BY ELECTRON-GAMMA DIRECTIONAL CORRELATION. Toshimitsu Yamazaki (Tokyo Univ.). Nucl. Phys., 44: 353-98(July 1963). (In English)

Electron-gamma directional correlation experiments for various cascades in Os^{188} and Os^{190} are performed by means of a sector-type double-focusing beta spectrometer. Spins and parities of the lower excited states are determined uniquely as follows: in Os^{188}, 478 kev, 4^+; 633 kev, 2^+; 790 kev, 3^+; and in Os^{190}, 548 kev, 4^+; 557 kev, 2^+; 755 kev, 3^+; 1161 kev, 4^+; and 1679 kev, 5^-. The M1/E2 mixing ratios in the 478-kev ($^22^+ \rightarrow {}^12^+$ in Os^{188}), 635-kev ($^13^+ \rightarrow {}^12^+$ in Os^{188}), 371-kev ($^22^+ \rightarrow {}^12^+$ in Os^{190}), and 569-kev ($^13^+ \rightarrow {}^12^+$ in Os^{190}) transitions are determined as +0.07 ± 0.03, +0.12 ± 0.07, +0.07 ± 0.03, and +0.07 ± 0.07 respectively. Nuclear matrix elements for electric monopole transitions between the second and the first 2^+ states are found to be $(2.2^{+0.8}_{-1.4}) \times 10^{-2}$ and $(2.5^{+1.5}_{-4.1}) \times 10^{-2}$ for Os^{188} and Os^{190} respectively, which elements can be accounted for by interaction between beta and gamma vibrations. The level schemes and transition properties associated with these lower excited states are discussed in connection with phenomenological collective models. (auth)

31457 INTENSITIES OF THE K-LL AUGER LINES. W. N. Asaad (Cairo Univ.). Nucl. Phys., 44: 399-414(July 1963). (In English)

The variation with Z of the intensities of the different lines in the K-LL Auger spectrum is calculated non-relativistically on intermediate coupling theory, using transition amplitudes calculated for all elements from Z = 12 to 41 and for ten additional atomic numbers in the range from Z = 44 to 80. The calculations are made assuming the coupling to be between the two final vacancies in the atom as well as between the initial vacancy in the atom and the hole in the continuum representing the 'missing' Auger electron. Agreement with experimental values is obtained, except for elements with large atomic number, for which relativistic effects cannot be ignored. Deviations from pure L-S coupling are found to begin practically from Z = 25, while extreme j-j coupling is not fully approached even at Z = 80. The differences introduced by treating the system as one of two electrons, rather than as one of two holes, are demonstrated. (auth)

31458 CALCULATION OF AUGER SPECTRA IN j-j COUPLING. W. N. Asaad (Cairo Univ.). Nucl. Phys., 44: 415-30(July 1963). (In English)

Selection rules for the Auger transitions in j-j coupling are derived. For this coupling, an expression is obtained for the Auger transition probability from any initial vacancy of the singly ionized atom to any final configuration of the doubly ionized atom. This expression is in terms of radial integrals, Clebsch-Gordan coefficients, and Racah coefficients. An alternative simpler form in which the Z-coefficients are used is also given. Tables giving the Auger transition probabilities, in terms of the appropriate radial integrals, are calculated for the cases of initial $s_{1/2}$, $p_{1/2}$, and $p_{3/2}$ vacancies, final vacancies up to $d_{3/2}d_{3/2}$ being covered. (auth)

31459 RESONANCES IN THE NEUTRON CROSS SECTION OF BISMUTH. F. W. K. Firk, J. E. Lynn, and M. C. Moxon (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 44: 431-8(July 1963). (In English)

The total neutron cross section of Bi^{209} is measured up to 19 kev. Five resonances are observed in this region. The neutron widths and total angular momenta $J\hbar$ of all five are measured. The resonances at 0.784 and 5.08 kev have J = 5, and the resonances at 2.23, 12.0, and 15.5 kev have J = 4. From these figures a lower limit can be set on the spin dispersion factor σ^2. It is only about 3% probable that σ^2 is less than 5, while on the other hand the data are consistent with the 2J + 1 level density rule holding for J as high as 5. (auth)

31460 DECAY OF NEODYMIUM 141. W. L. Alford, D. R. Koehler, and R. G. Polk (Army Missile Command,

Redstone Arsenal, Ala.). Nucl. Phys., 44: 439-42(July 1963). (In English)

A report is given of the experimental study of the Nd^{141} activity resulting from 14-Mev neutron bombardment of Nd^{142}. The Nd^{141} decay is found to take place mainly by electron capture, with positron emission occurring approximately 3% of the time. Gamma rays are observed with energies of 1.30, 1.16, 1.13, and 0.14 Mev. Evidence is found for a level in Pr^{141} at 1.13 Mev. (auth)

31461 THE ENERGY LEVELS OF I^{129}. G. N. Rao, V. R. Potnis, and H. S. Hans (Muslim Univ., Aligarh, U.P., India). Nucl. Phys., 44: 443-52(July 1963). (In English)

The energy levels of I^{129} are studied through the β^- decay of Te^{129m} and Te^{129}, employing two NaI(Tl) scintillation spectrometers in coincidence arrangement. The gamma rays detected have energies of 27, 212, 475, 720, 1120, 448, 450, 625, 693, 1073, 1320, and 1520 kev. From the coincidence experiments a probable energy level scheme for I^{129} is proposed. (auth)

31462 THE $F^{19}(p,n)Ne^{19}$ REACTION BETWEEN 5 AND 11 Mev. J. G. Jenkin, L. G. Earwaker, and E. W. Titterton (Australian National Univ., Canberra). Nucl. Phys., 44: 453-9(July 1963). (In English)

The excitation function and cross section for total neutron emission from the $F^{19}(p,n)Ne^{19}$ reaction are measured by an activation technique from 4.9 to 11.0 Mev proton energy. An interpretation of the structure in the excitation function in terms of compound nucleus states is offered. (auth)

31463 PHASE RELATION IN NUCLEAR SCATTERING. D. R. Inglis (Argonne National Lab., Ill.). Nucl. Phys., 44: 460-71(July 1963). (In English)

The observation that the maxima of elastic scattering of such particles as alphas on fairly heavy nuclei coincide with the minima of inelastic scattering (with no parity change) is explained in as elementary a way as possible in terms of the simple superposition of waves, without dependence on special functions. Some qualitative features of the relation between this treatment and a better approximation are discussed. (auth)

31464 EXCHANGE EFFECT IN THE SCATTERING OF AN α-PARTICLE BY LIGHT NUCLEI. T. Honda, Y. Kudo, and H. Ui (Tohoku Univ., Sendai). Nucl. Phys., 44: 472-85(July 1963). (In English)

Exchange effects are discussed in the elastic and inelastic scattering of an α particle by light nuclei. It is pointed out that, in addition to the usual exchange scattering, there is another sort of exchange effect that corresponds to the heavy-particle-stripping in a nuclear rearrangement collision. This process is shown to play an important role in the angular distribution in the backward direction, when the structures of both the target and residual nuclei are amenable to the α-cluster model. In the cut-off Born approximation the cross section for the process is presented in such a form as to contain no energy-dependent adjustable parameters. The elastic scattering of α particles by C^{12} is analyzed in the energy region between 15 and 42 Mev; it is found that very sharp backward peaking observed in the angular distribution at about $E_\alpha = 18$ Mev can be reproduced by the calculation. The reduced width of the α particle is determined for the ground state of C^{12}. The cluster structure of C^{12} is discussed. It is suggested that the ground state of C^{12} should be a mixture of the fourth order oscillation 3s, 2d, and 1g states in the Be^8-α-cluster representation, the mixing ratio of the 3s state being at most $\frac{1}{2}$. (auth)

31465 INTERFERENCE EFFECTS IN THE $C^{12}(p,\gamma)N^{13}$ REACTION. F. C. Young (Univ. of Maryland, College Park and Naval Research Lab., Washington, D. C.), J. C. Armstrong, and J. B. Marion. Nucl. Phys., 44: 486-98 (July 1963). (In English)

The ground-state transition in the $C^{12}(p,\gamma)N^{13}$ reaction is studied in detail for the range of proton bombarding energies from 1.5 to 2.0 Mev. The measured angular distributions show large asymmetries, which are strongly energy-dependent. Calculations with a resonance-capture mechanism indicate that the angular distributions and energy dependence of the cross section can be interpreted in terms of the 1.70-Mev resonance ($N^{13*} = 3.51$ Mev) interfering with the 0.46-Mev resonance ($N^{13*} = 2.37$ Mev). A contribution from the 3.56-Mev level in N^{13} to the cross section is not detected in any of the excitation curves or angular distributions. Calculations based on possible interference effects from the 3.56 Mev level yield an upper limit for the (p,γ) cross section proceeding through this state of 0.16 μb ($\omega\Gamma_\gamma < 0.006$ ev). The (p,γ) cross section for the 3.51 Mev level is found to be 37 μb ($\omega\Gamma_\gamma = 1.06$ ev). (auth)

31466 EXCITATION FUNCTIONS AND ANGULAR DISTRIBUTIONS OF α PARTICLES FROM PROTON BOMBARDMENT OF ^{26}Mg. L. G. Lawrence and H. J. Hay (Australian National Univ., Canberra). Nucl. Phys., 44: 518-28(July 1963). (In English)

Excitation functions of α particles leading to the ground and first excited states of Na^{23} are measured at laboratory angles of 90 and 135° over the proton energy range 6.0 to 9.0 Mev. These functions are consistent with a number of resonances in the compound nucleus Al^{27}, and these resonances are tabulated in terms of incident proton energies. Angular distributions of the two α particle groups are measured in proton energy steps of 15 kev in the ranges 6.390 to 6.645 Mev and 8.70 to 8.91 Mev. A least-squares fit of the distributions as functions of Legendre polynomials is carried out. (auth)

31467 THE EFFECT OF PAIRING CORRELATIONS ON NUCLEAR TRANSITION RATES. A. F. de Miranda and M. A. Preston (McMaster Univ., Hamilton, Can.). Nucl. Phys., 44: 529-45(July 1963). (In English)

An attempt is made to study the influence of pairing correlations in some γ and β decay processes, using projected wave functions that are eigenfunctions of the number operator, and that have extremely large overlaps with the exact solutions of the pairing hamiltonian. It is not much more difficult to obtain accurate numerical results with the new wave functions than it is with the usual Bardeen-Cooper-Schrieffer wave functions. The results show some appreciable differences between the two types of wave functions, which in some β-decay cases can be as much as 10 to 25%, when the same single particle level structure and pairing force parameters are used. Also the β-decay results are compared with those calculated by Soloviev in order to illustrate the sensitivity to the single-particle spectrum assumed. The ratio of M4 transitions in Pb and Sn isotopes are found to be insensitive to the use of projected wave functions, but the rates in the N = 50 isotopes are appreciably altered. In general, the projected wave functions indicate that pairing correlations can account for only part of the configuration mixing required to explain the large deviations from single particle values that are experimentally observed. (auth)

31468 ELASTIC SCATTERING OF 24.85-Mev DEUTERONS BY He^4. W. T. H. Van Oers and K. W. Brockman,

Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., 44: 546-52(July 1963). (In English)

The differential cross section for elastic scattering of 24.85 Mev deuterons by He^4 was measured by observing both elastically scattered deuterons and the recoil alpha particles. The angular distribution shows a similar behavior to those found at lower energies except in the region around 60° where a new relative maximum in the cross section appears. (auth)

31469 CHARGE DISTRIBUTION IN PHOTOFISSION OF U^{238} AND Th^{232}. J. G. Cuninghame, M. P. Edwards, G. P. Kitt, and K. H. Lokan (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 44: 588-96(July 1963). (In English)

The independent fission yields of four fission products of U^{238} and three of Th^{232} photofission by thick-target bremsstrahlung of 23 Mev maximum energy, were measured. The results are in general agreement with the proposal of equal charge displacement, and in strong disagreement with unchanged charge distribution. Both points for Nb^{96}, however, are low by more than two orders of magnitude, an effect previously noticed by others for this nucleide. A number of cumulative yields, mainly on the wings of the mass-yield curve, were also measured. (auth)

31470 THE ENERGY AND ANGULAR DISTRIBUTION OF PROTONS FROM 14.8-Mev NEUTRON REACTIONS WITH Al^{27} AND Co^{59}. R. K. Mohindra and H. S. Hans (Muslim Univ., Aligarh, U.P. India). Nucl. Phys., 44: 597-606(July 1963). (In English)

The energy and angular distribution of protons from Al^{27} and Co^{59} when bombarded by 14.8 Mev neutrons was studied by using a triple coincidence and an anticoincidence proton scintillation spectrometer. The observed spectra were compared to the calculated ones, on the basis of the volume direct interaction and the statistical models. Various level density formulas based on the Fermi gas model of the nucleus were tried and it was noted that the level density formulas of Lang-LeCouteur and Newton give the best results. The agreement between the theory and experiment is only qualitative. The behavior of the nuclear temperature is studied at various angles. (auth)

31471 SCATTERING FROM ORIENTED DEFORMED NUCLEI. K. T. R. Davies, G. R. Satchler, R. M. Drisko, and R. H. Bassel (Oak Ridge National Lab., Tenn.). Nucl. Phys., 44: 607-24(July 1963). (In English)

The elastic scattering of particles from oriented, deformed, odd-mass nuclei is studied, using the collective model of the nucleus. Numerical results, obtained using the distorted-wave Born-approximation, are presented for some typical cases, namely neutrons of 2, 5, and 14 Mev, protons of 5 and 14 Mev, and alphas of 43 Mev, incident on Mn^{55} and Ho^{165} target nuclei. It is found that the differential cross-section shows large azimuthal asymmetries when the target is oriented perpendicular to the incident beam. The experimental observation of this effect would be valuable; for rotational nuclei it could measure the sign and magnitude of the deformation, while for vibrational nuclei it could yield important information about the coupling of the odd nucleon to the core. (auth)

31472 LEVELS IN N^{15} FROM $B^{11}(\alpha,p_0)C^{14}$ REACTION. G. S. Mani (Centre d'Etudes Nucleaires, Saclay, France), P. D. Forsyth, and R. R. Perry. Nucl. Phys., 44: 625-32 (July 1963). (In English)

The angular distributions for the emission of protons from the $B^{11}(\alpha,p_0)C^{14}$ reaction were measured in the energy region from 2.5 to 5.0 Mev alpha energy. The angular distribution in the energy region 3.2 to 4.5 Mev shows a very pronounced structure due to a large number of competing levels of opposite parity in the compound nucleus, N^{15}. The levels of N^{15} in the region of excitation 12.8 to 14.5 Mev were obtained. (auth)

31473 THE SURFACE OF LIGHT NUCLEI. G. C. Thomas and N. W. Tanner (Oxford Univ.). Nucl. Phys., 44: 647-52(July 1963). (In English)

The process of direct radiative capture of protons by O^{16}, Ne^{20}, and Ca^{40} is interpreted in terms of the nuclear density distribution of the final states of F^{17}, Na^{21} and Sc^{41}. A Saxon-Woods potential with the conventional parameters $R_0 = 1.3$ fm and $a = 0.7$ fm is found to give a density in reasonable agreement with the direct capture measurements. In the case of F^{17} the density distribution that is obtained from direct capture is used to calculate the quadrupole decay of the first excited state of F^{17}. Introducing the core contribution known from the corresponding transition in O^{17} gives a F^{17*} lifetime of 0.19 ± 0.05 ns in gross disagreement with the measured lifetime of 0.44 ± 0.02 ns. (auth)

31474 THE POSITON SPECTRUM OF Dy^{155}. L. Persson, H. Ryde, and K. Oelsner-Ryde (Nobel Inst. of Physics, Stockholm). Nucl. Phys., 44: 643-63(July 1963). (In English)

The positron spectrum emitted in the decay of Dy^{155} to Tb^{155} was studied by means of a large double-focusing beta ray spectrometer and an intermediate image beta ray spectrometer. Two components in the positron spectrum were observed with the end-point energies 850 ± 6 and 1075 ± 8 kev. By positron-gamma coincidence measurements the 850 kev positron branch was found to feed the 227 kev level in Tb^{155}. The total decay energy of Dy^{155} was thus deduced to be 2099 ± 6 kev and this value is compared with that obtained from a semi-empirical atomic mass formula and with the available decay energies of the other odd-mass dysprosium isotopes. The K/β^+ ratio for the beta transition to the 227 kev level was found to be 44 ± 5, in close agreement with the theoretical value expected for an allowed transition. The log ft values for the beta transitions to the 227 kev and the ground state of Tb^{155} were found to be 6.1 and 7.7, respectively. The spin, parity, and the asymptotic quantum numbers of the ground state of Dy^{155} are discussed. For this state the most probable classification is $^3/_2^-$ [521]. (auth)

31475 PROTON CAPTURE γ-RAYS FROM Be^8 IN THE GIANT RESONANCE REGION. I. V. Mitchell and R. B. Taylor (Australian National Univ., Canberra). Nucl. Phys., 44: 664-9(July 1963). (In English)

The excitation function of the $Li^7(p,\gamma)Be^8$ reaction was measured at 90° for proton energies between 2.5 and 9 Mev. Transitions to the ground state and first excited state exhibit broad resonances at $E_p \approx 5$ and 7.3 Mev, respectively, with evidence for a subsidiary peak at $E_p \approx 6$ Mev in the γ_1 yield. The angular distributions for both components remain nearly constant over a 5 Mev range of proton energy. (auth)

31476 K/(L + M) CONVERSION RATIOS IN THE DECAY $Pm^{148} \rightarrow Sm^{148}$. T. J. Kurey, Jr. and R. R. Roy (Pennsylvania State Univ., University Park). Nucl Phys., 44: 670-9(July 1963). (In English)

The K/(L + M) conversion ratios of the 286, 550, and 627 kev transitions among the excited states of Sm^{148} populated by the decay of Pm^{148} were measured using a shallow diffused silicon p-n junction detector. The reliability of

the p-n junction detector as an instrument for the quantitative measurement of K/(L + M) conversion ratios was established by measuring the K/(L + M) conversion ratios of Hg^{203}, Au^{198}, Cs^{137}, and Bi^{207} and comparing the values obtained with those of previous workers using other methods. For the measurements of the K/(L + M) conversion ratios of the transitions in Sm^{148}, the p-n junction detector was employed in an arrangement that afforded the use of beta-gamma coincidence techniques. The following values were obtained: $(K/(L + M))_{286} = 7.0 \pm 1.0$; $(K/(L + M))_{550} = 5.1 \pm 0.3$; $(K/(L + M))_{627} = 5.4 \pm 0.4$. The K/(L + M) ratio measured for the 286 kev transition, considered with the results of others, permits an M1 + E2 multipolarity assignment to this transition and indicates a $6^+ \rightarrow 6^+$ transition between the 2.19 and 1.90 Mev states in Sm^{148}. (auth)

31477 ENERGY AND ANGULAR DISTRIBUTIONS FOR THE $Al^{27}(n,\alpha)Na^{24}$ REACTION WITH 14-Mev NEUTRONS. C. J. D. Jarvis, W. R. Dixon, and R. S. Storey (National Research Council, Ottawa). Nucl. Phys., 44: 680-93(July 1963). (In English)

The $Al^{27}(n,\alpha)Na^{24}$ reaction at a neutron energy of 14.1 Mev was studied by the nuclear emulsion technique. As a result of careful shielding of the emulsion, a thin aluminum target could be used and it was possible to achieve an energy resolution of 4% at 9 Mev. The energy distribution of the alpha particles shows peaks corresponding to the first few energy levels in the residual Na^{24} nucleus. The emission of the low energy alpha particles is nearly isotropic, while in the higher energy region there is some preferential emission in the forward direction. Analysis of the energy and angular distributions indicates that the statistical theory is adequate to account for most of the alpha particles. The value of the spin cut-off parameter for the energy interval 4-7 Mev is found. The effect of Ericson fluctuations in the statistical analysis is discussed briefly. The background tracks were also examined: high-energy alpha particles from heavy constituents of the emulsion are peaked strongly forward; low-energy alpha particles from light constituents are peaked in both the forward and backward directions. (auth)

31478 RESONANCE INTEGRAL CALCULATIONS FOR U^{238} LATTICES. Melvin M. Levine (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 16: 271-9(July 1963). (BNL-6695)

Computed resonance integrals are compared with precise results from a series of Monte Carlo calculations with very large numbers of histories. The range of applicability of the original computation method is exhibited by this comparison. Some simplifications are made in the method of presentation of the resonance integral results so that the correlation among single lumps and lattices of various compositions is improved. (auth)

31479 RESONANCE ABSORPTION IN MATERIALS WITH GRAIN STRUCTURE (ADDENDUM). L. W. Nordheim (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 16: 337-8(July 1963).

An analysis of resonance absorption of neutrons in materials having grain structures is extended to the case in which the grains occupy a sizeable fraction of the absorber volume. (T.F.H.)

31480 FURTHER MEASUREMENTS ON THE NUCLEAR MAGNETIC PROPERTIES OF ADSORBED He^3. G. Careri, M. Giura, and M. Santini (Università, Rome). Phys. Letters, 5: 102(June 15, 1963). (In English)

More extensive measurements by an improved method established that the nuclear magnetization in a monolayer of He^3 adsorbed on zeolite does follow the Curie law. He^3 adsorbed on 1 gr of zeolite in the concentration and temperature ranges of 50 to 100 cc and 4.2 to 2°K is concluded to show nuclear paramagnetic behavior. (D.C.W.)

31481 HFS COUPLING OF THE 123 kev STATE OF Gd^{154}. P. B. Treacy (Australian National Univ., Canberra). Phys. Letters, 5: 117-18(June 15, 1963). (In English)

A previously developed method is shown to be applicable to the analysis of γ-γ angular correlation data in order to determine HFS couplings and nuclear magnetic moments of γ-emitting states of nuclei. The correlation between the 123-kev γ ray from Gd^{154} and a preceding γ ray is considered. Attenuation coefficients and correlation times were calculated. Reasonable values for the latter were obtained, but the observation of production of attenuation by a strong magnetic field perpendicular to the correlation plane could not be explained. (D.C.W.)

31482 COLLECTIVE SYSTEMATICS IN EVEN NUCLEI BY NUCLEAR REACTION SPECTROSCOPY. R. K. Sheline, W. N. Shelton, and R. A. Kenefick (Florida State Univ., Tallahassee). Phys. Letters, 5: 129-31(June 15, 1963). (In English)

Proton spectra for the reactions (p,p′) and (d,p) leading to a number of even rare earth nuclei of Sm, Gd, Dy, and Er were obtained for incident energies of 12 Mev. Striking variation of the cross sections with the change in nature of the states was observed. Information on the population of various state rotational bands by each reaction was derived. The energy gap corresponding to breaking the first neutron pair is discernible in the (d,p) cross section. (D.C.W.)

31483 THE PROTON POTENTIAL ANOMALY AND (p,n) REACTIONS. J. D. Anderson and H. Mark (Univ. of California, Livermore). Phys. Letters, 5: 136-7(June 15, 1963). (UCRL-7333). (In English)

Quantitative comparisons are made between the isobaric spin term recently introduced into the nuclear optical potential and the so-called proton potential anomaly. Agreement of neutron-proton potential differences calculated using a velocity-dependent interaction in the effective mass approximation and by averaging over the isotopic spin states of the nuclei shows that the isotopic spin interaction of the incident particle and the nucleus can account for the neutron-proton potential difference introduced to obtain the correct neutron-proton ratio. (D.C.W.)

31484 LOW-ENERGY (p,n) REACTION OF Mn^{55} AND THE EXCITED STATES OF Fe^{55}. H. J. Kim (Oak Ridge National Lab., Tenn.). Phys. Letters, 5: 138-9(June 15, 1963). (In English)

Low-lying states of Fe^{55} were obtained by the reaction $Mn^{55}(p,n)Fe^{55}$. Neutron spectra show two unreported neutron groups in addition to the groups corresponding to ground, 413, and 933-kev states of Fe^{55}. Fluctuations in the excitation functions of a nature explained in terms of a coherence energy were clearly observed. Angular distributions of the neutron groups were asymmetric about 90°, and the excitation functions for the different groups fluctuated together, implying non-validity of statistical compound reaction assumptions for this investigation. (D.C.W.)

31485 ELECTRODISINTEGRATION OF Li^6. G. R. Bishop and M. Bernheim (Ecole Normale Supérieure, Orsay, France). Phys. Letters, 5: 140-1(June 15, 1963). (In English)

For the (γ,n) reaction in Li^6, a model in which Li^6 splits into a deuteron and an α particle that separately absorb the photon energy was recently proposed. The model was

tested by studying the inelastic scattering of 101.4-Mev electrons from Li^6. Expressions for the cross sections were obtained, and values calculated for a form factor in the cross sections confirm the validity of the model. (D.C.W.)

31486 CALCULATION OF LEVELS OF LEAD ISOTOPES OF A < 207. R. Arvieu and M. Veneroni (Laboratoire Joliot-Curie de Physique Nucléaire, Orsay, France). Phys. Letters, 5: 142-5(June 15, 1963). (In French)

The 0^+, 1^+, 2^+, 3^+, 4^+, 5^-, 6^-, 7^-, and 9^- states of Pb^{206}, Pb^{204}, Pb^{202}, and Pb^{200} were calculated using the random phase approximation and a diagonalization in the subspace of the states to two quasi-particles. The interaction parameters used by Ford and True in a study of Pb^{206} were used, but no adjustable parameters were included. The energies, spins, and parities of the twenty first levels calculated for each isotope are given. The agreement with experimental results is surprisingly good since adjustable parameters are excluded. (D.C.W.)

31487 PHOTODISINTEGRATION OF He^3. A. N. Gorbunov and A. T. Varfolomeev (Lebedev Inst. of Physics, Moscow). Phys. Letters, 5: 149-50(June 15, 1963). (In English)

The photodisintegration of He^3 by the reactions $He^3(\gamma,p)d$ and $He^3(\gamma,n)2p$ was studied by placing a cloud chamber filled with He^3 in a magnetic field in a bremsstrahlung beam. The (γ,p) cross section was found to have a broad maximum at about 18 Mev and a maximum value of 1.2 mb. A (σ_{-1}) value of 3 ± 0.3 mb was obtained for this reaction, as well as an integral cross section of 30 ± 3 Mev mb. Assuming equality of the yields for the two reactions gave an integral cross section for photon absorption of 60 ± 6 Mev mb, in agreement with theoretical values. (D.C.W.)

31488 POSSIBILITY OF DETECTING DIRECT INTERACTION ADMIXTURE IN INELASTIC NUCLEON SCATTERING AT LOW ENERGIES. E. Sheldon (Eidgenossische Technische Hochschule, Zurich). Phys. Letters, 5: 157-8 (June 15, 1963). (In English)

It is noted that a correlation function that is isotropic for the compound nucleus mechanism and undulating for direct interaction would permit observation of the latter. The transition sequence $3/2 \rightarrow J_1 \rightarrow 1/2 \rightarrow 3/2$, resulting from inelastic nucleon scattering on nuclei, is shown to have special promise, and detection of the direct interaction contribution to the double-differential cross section for such scattering is considered. (D.C.W.)

31489 INTERNAL CONVERSION COEFFICIENT OF 14.4 kev Fe^{57} TRANSITION. A. H. Muir, Jr. (North American Aviation Science Center, Canoga Park, Calif.), E. Kankeleit, and F. Boehm. Phys. Letters, 5: 161-5(June 15, 1963). (In English)

The ratio of the 14-kev K x-ray intensity to the 14-kev γ-ray intensity was measured with both an argon-methane proportional counter and a NaI scintillation crystal. Conversion coefficients were also obtained. The K-shell internal conversion coefficient, and the total conversion coefficient were determined to be 8.44 ± 0.5 and 9.51 ± 0.5, respectively. (D.C.W.)

31490 CORRELATION STUDIES OF THE α-PARTICLE BREAKUP OF THE 9.6 Mev 3^- STATE IN C^{12} INDUCED BY (α,α') SCATTERING. R. A. Lasalle, J. G. Cramer, Jr., and W. W. Eidson (Indiana Univ., Bloomington). Phys. Letters, 5: 170-2(June 15, 1963). (In English)

The theoretical prediction that the correlation function of α particles from even-even nucleus break-up would have a simple dependence on the azimuthal angle at certain values of the polar angle was verified. The 9.6-Mev 3^- state in C^{12} was obtained by bombarding C with 22.5-Mev alpha particles and the correlations for the resultant alphas were obtained. The 3^- assignment of the 9.6-Mev state was also confirmed. (D.C.W.)

31491 BETA DECAY AND SPIN OF THE Pr^{144} GROUND STATE. R. S. Raghavan and R. M. Steffen (Purdue Univ., Lafayette, Ind.). Phys. Letters, 5: 198-9(July 1, 1963). (In English)

The suggested spin assignment of $I_0 = 1^-$ for the ground state was tested by measuring the energy dependence of the β-γ directional correlation of the $(?) - \beta_2 \rightarrow (2^+) - \gamma_1 \rightarrow (0^+)$ cascade. Experimental results for the anisotropy factor in the β-γ directional correlation function agree very well with the correlation factor expected for a unique β-transition in a $(0^-) - \beta_2 \rightarrow (2^+) - \gamma \rightarrow (0^+)$ cascade, giving support to the previous 0^- assignment for this state. (D.C.W.)

31492 FAST NEUTRON SCATTERING BY ELEMENTS NEAR AND AT CLOSED SHELLS. P. Huber, R. Plattner, C. Poppelbaum, and R. Wagner (Universität, Basel). Phys. Letters, 5: 202-3(July 1, 1963). (In English)

A time-of-flight spectrometer with a time range of 200 nanosec was used to obtain the energy spectra from 14-Mev neutrons inelastically scattered by a number of elements. The Le Couteur formula was used to obtain the nuclear temperature, and the level density coefficients were also determined. The results agree with the theoretical work of Newton and Rosenzweig for $40 \leq Z \leq 50$. The level density shows the expected decreases near the magic neutron numbers 82 and 126, but the effect found by Rosenzweig near the magic proton number 50 is absent. (D.C.W.)

31493 THE FORWARD-BACKWARD ASYMMETRY OF RECOIL NUCLEI IN THE REACTION $Al^{27}(n,\alpha)Na^{24}$. W. R. Dixon and R. S. Storey (National Research Council, Ottawa). Phys. Letters, 5: 208(July 1, 1963). (In English)

The forward-backward asymmetry obtained by Csikai for the $Al^{27}(n,\alpha)Na^{24}$ reaction with 14.8 Mev neutrons supports sharp forward and backward peaking in the angular distribution thereby indicating low values for the spin cut-off parameters. Calculations of the forward-backward asymmetry ratio show that the ratio depends less on the form of the angular distribution than on the form of the energy spectrum. Thus, measurement of this ratio alone can not determine the correct angular distribution. (D.C.W.)

31494 VALIDITY OF THE DWBA FOR INELASTIC SCATTERING FROM NUCLEI. F. Perey and G. R. Satchler (Oak Ridge National Lab., Tenn.). Phys. Letters, 5: 212-15(July 1, 1963). (In English)

Coupling between ground and excited states was suggested to limit the usefulness of the distorted-wave Born approximation (DWBA) to a rather narrow limit of deformations. Comparison of calculations for the scattering of 10 to 22-Mev protons by Fe^{56} as made with the DWBA and with coupled Schroedinger equations show that the DWBA has a considerably wider range of validity. (D.C.W.)

31495 ON THE IMPORTANCE OF THE RANGE OF INTERACTIONS IN STRIPPING AND KNOCKOUT AMPLITUDES. F. B. Morinigo (California Inst. of Tech., Pasadena). Phys. Letters, 5: 215-16(July 1, 1963). (In English)

Tanifuji's calculations on the knockout mode for stripping reactions using the cut-off Born approximation and delta function interactions indicated that the knockout amplitude is forward peaked, while the heavy-particle knockout am-

plitude is backward peaked. These results are shown to arise from his use of an extremely short-range interaction. Entirely opposite results can be obtained when the amplitude is calculated in the Born approximation without a cut-off, using harmonic oscillator wave functions and interactions with gaussian shape. (D.C.W.)

31496 PROTON SPECTRA FROM THE p + D REACTION FOR 5-10 Mev INCIDENT PROTONS. Joseph L. Friedes and Morton K. Brussel (Univ. of Illinois, Urbana). Phys. Rev., 131: 1194-1202(Aug. 1, 1963).

The proton spectra from the p + D → 2p + n reaction have been measured at the four laboratory energies, 10.62, 9.19, 6.97, and 5.53 Mev, and at the two laboratory angles, 14° and 34°. The proton beam from the University of Illinois cyclotron was used to bombard a deuterated polyethylene target. The breakup protons were recorded by a thin CsI scintillation counter used in conjunction with a magnetic spectrometer. The energy resolution of the system was approximately one percent and the minimum energy for which reliable data could be obtained was 1 Mev. All of the spectra have fewer low energy protons than would be predicted by phase space arguments alone. They all exhibit rather steep slopes near the maximum breakup energy, reaching one-third to one-half maximum height in less than $\frac{1}{4}$ Mev. The slope then decreases, the cross section rising to a maximum near $E/E_{max} = \frac{1}{2}$. Structure, in the form of a "knee" in the spectrum, has been observed near the maximum breakup energy for all the spectra with incident proton energies greater than 7 Mev. This structure becomes more pronounced as the scattering angle increases and less pronounced as the incident energy decreases. Similar structure has also been observed near the low energy end of the spectrum for the 10.6-Mev incident proton energy. The present observations have been compared with the less complete work of other investigators, and the agreement was found to be excellent. A qualitative understanding of the observed structure is provided by the final-state interaction formalism of Watson. A comparison with the impulse approximation theory of Frank and Gammel has also been made and the agreement is rather poor. (auth)

31497 FISSION FRAGMENT KINETIC ENERGIES OF Cf^{246}, Cf^{248}, AND Cf^{254}. A. M. Friedman, J. W. Meadows, A. B. Smith, R. P. Fields, J. Milsted, and J. F. Whalen (Argonne National Lab., Ill.). Phys. Rev., 131: 1203(Aug. 1, 1963).

Fission fragment kinetic energy spectra of Cf^{246}, Cf^{248}, and Cf^{254} were measured by comparison to Cf^{252}. The most probable fragment energies were (in Mev): Cf^{246}, 84.8 ± 1.3 and 110.8 ± 1.5; Cf^{248}, 81.6 ± 0.9 and 107.1 ± 0.8; Cf^{254}, 83.0 ± 2 and 103.1 ± 2. (auth)

31498 TWO-PARAMETER ANALYSIS OF Be^{10}, B^{11}, B^{12}, AND B^{13} SPECTRA. R. R. Carlson and E. Norbeck (State Univ. of Iowa, Iowa City). Phys. Rev., 131: 1204-11(Aug. 1, 1963).

Bound states of Be^{10}, B^{11}, B^{12}, and B^{13} were formed by bombardment of Li^7 with 3-Mev Li^7 ions and were studied by two-parameter analysis. Gamma radiation from these states and particles associated with their production were measured in coincidence. A 256 × 256-channel two-parameter analyzer made up of a general purpose computer and two 256-channel pulse-height analyzers was used. The gamma-ray emission from individual bound states of the above nuclei was obtained uncontaminated by cascade feeding of levels. Gamma-ray branching ratios of levels in Be^{10} and B^{11} confirm previous measurements. Gamma-ray branching ratios of the bound levels of B^{12} and B^{13} were measured for the first time. The pattern of gamma-ray branching ratios of B^{13} bears a certain resemblance to that for B^{11}. The first excited state of B^{13} previously believed to be at 3.70 Mev was found to be a doublet at 3.50 ± 0.05 Mev and 3.70 ± 0.05 Mev. (auth)

31499 HEAVY-PARTICLE STRIPPING IN THE $Be^9(He^3,\alpha)Be^8$ REACTION AND ENERGY LEVELS OF Be^8. W. E. Dorenbusch and C. P. Browne (Univ. of Notre Dame, Ind.). Phys. Rev., 131: 1212-18(Aug. 1, 1963).

Angular distributions of alpha particles from the $Be^9(He^3,\alpha)Be^8$ reaction leading to the ground state and the levels at 2.9, 16.6, 16.9, and 17.6 Mev were measured at bombarding energies of 3.00 and 4.00 Mev. Reaction alphas were momentum-analyzed with a broad-range spectrograph. Angular distributions for the ground state and the levels at 2.9 and 16.9 Mev are analyzed with a direct reaction theory which includes both the pickup and the heavy-particle stripping amplitudes. Yield measurements for the 17.6-Mev level were not made for angles larger than 100 deg. Over this limited range in angle the angular distributions for this level are in agreement with the predictions of Butler theory. The formation of the 16.6-Mev level apparently proceeds via the compound nucleus. Absolute differential cross sections were found by comparison with the known cross section for the $Be^9(d,p)Be^{10}$ reaction. Cross sections for the $Be^9(He^3,\alpha)Be^8$ reaction vary from 0.5 mb/sr to 7.6 mb/sr. The level structure of Be^8 was studied from the ground state up to 17.6-Mev excitation. Levels were found at excitation energies of 2.90 ± 0.04, 16.633 ± 0.015, 16.928 ± 0.015, and 17.639 ± 0.010 Mev, with the indication of a very broad level in the region of 12.5 Mev. Widths of the 2.9-, 16.6-, and 16.9-Mev levels are 1350 ± 150, 96 ± 20, and 80 ± 15 kev, respectively. (auth)

31500 RADIATIVE CORRECTIONS IN THE ANGULAR CORRELATION OF MONOPOLE PAIRS FROM O^{16} AT SMALL ANGLES. S. Gorodetzky (Centre National de la Recherche Scientifique, Strasbourg), F. Scheibling, R. Armbruster, W. Benenson, P. Chevallier, P. Mennrath, G. Sutter, and G. Goldring. Phys. Rev., 131: 1219-23(Aug. 1, 1963).

The angular correlation of electron-positron pair emission in the $0^+ \rightarrow 0^+$ transition in O^{16} was investigated for very small angles. An enhancement of several percent in the emission rate at these small angles is expected, due to first-order radiative corrections represented principally by the vertex graph. The rapid rise in the correlation at small angles was experimentally verified, and the results are in agreement with the theory. (auth)

31501 COULOMB EXCITATION OF Tc^{99} AND Sm^{147}. J. C. Albergotti and P. E. Shearin (Univ. of North Carolina, Chapel Hill). Phys. Rev., 131: 1224-7(Aug. 1, 1963).

Coulomb excitation gamma-ray spectra from Tc^{99} and Sm^{147} have been investigated by means of 2-Mev protons. A NaI(Tl) scintillation spectrometer was used to measure the energy and intensity of the gamma rays. Gamma rays of energy 120 ± 3.2 kev and 199 ± 4.1 kev were observed from the excited nucleus Sm^{147}. In the case of Tc^{99}, gamma rays of energy 140 ± 3.5 kev and 178 ± 4.0 kev were observed. Total reduced transition probabilities for these transitions are of the same order of magnitude as the single-particle estimate. (auth)

31502 POSITRON DECAY OF Co^{58}. J. I. Rhode and O. E. Johnson (Purdue Univ., Lafayette, Ind.). Phys. Rev., 131: 1227-31(Aug. 1, 1963).

The allowed positron transition from the Co^{58} ground state (2+) to the Fe^{58} first excited state (2+, 810 kev) was

studied using a 4π positron-scintillation spectrometer. The experimental shape factor exhibits a small systematic deviation from that theoretically predicted for an allowed transition and corresponds to an excess of low-energy positrons. The experimental shape factor can be fit by a curve proportional to (1 + b/W) with b = 0.3. The Fermi-Kurie plot is linearized by this correction factor and yields an end-point energy of 474 ± 5 kev. Similar discrepancies between the experimental and theoretically predicted shapes of Gamow-Teller beta transitions for negatrons (In^{114}, P^{32}, and Y^{90}) and positrons (Na^{22}) have been reported. In these cases it was found that this same shape factor with 0.2 < b < 0.4 would linearize the theoretically-corrected Fermi-Kurie plots. No satisfactory explanation for this effect has been offered. As previously suggested by other investigators, the shape factor (1 + b/W) must, for the present, be regarded as a purely empirical correction. The end-point energy from the present investigation combined with the recent high-precision measurement of the gamma-ray transition energy from the first excited state to the ground state of Fe^{58} yields a Co^{58}-Fe^{58} mass difference of 2306 ⋆ 5 kev. (auth)

31503 COINCIDENT TIME-OF-FLIGHT MEASUREMENTS OF THE VELOCITIES OF Cf^{252} FISSION FRAGMENTS. Stanley L. Whetstone, Jr. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 131: 1232-43(Aug. 1, 1963). (LADC-5632)

The primary object of the experiment was to improve the absolute accuracy of the determination of the mean values of the distributions in fragment velocity, mass, and kinetic energy. Absolute uncertainties attained are estimated to be about ±0.5% for the velocity measurements (~±1% for the energy measurements); statistical uncertainties on the distribution mean values are considerably smaller. Mean velocities of 1.036 and 1.375 cm/nsec, mean mass numbers of 143.61 and 108.39 amu, and mean kinetic energies of 80.01 and 105.71 Mev, respectively, were obtained for the heavy- and light-fragment groups. The mean total-fragment kinetic energy was found to be 185.7 Mev, and the mean mass ratio, 1.334. Perturbations, suggesting fine structure, are found in the primary mass yields. Associated perturbations are observed in the average total-fragment kinetic energy ($E_K(R_A)$) for the corresponding mass divisions. A decrease in ($E_K(R_A)$) near symmetric mass division, extending over five or six mass pairs and reaching about 20 Mev at a mean mass ratio of 1.0, was observed; but the absolute uncertainty is large. (auth)

31504 THREE-BODY EFFECT IN NUCLEAR MATTER TO ALL ORDERS OF PERTURBATION. R. Rajaraman (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 131: 1244-8 (Aug. 1, 1963).

It is shown that there are three-body clusters in all orders of the Goldstone expansion for the binding energy of nuclear matter and that they converge extremely poorly. A Γ matrix is defined which, on expansion, is shown to generate this infinite sequence of three-nucleon clusters. It is shown that the Γ matrix can be evaluated in terms of a three-body correlation function for which a differential equation is derived. Solving this equation leads to the evaluation of Γ. This demonstrates that a finite sum does exist for these cluster diagrams, and gives a method for finding it. Finally, it suggests that for strong short-range potentials it is better to expand the binding energy in powers of the density rather than in powers of the interaction. (auth)

31505 POSSIBLE EXISTENCE OF CURIUM IN NATURE. [PART] II. P. R. Fields, A. M. Friedman, J. Lerner, D. Metta, and R. Sjoblom (Argonne National Lab., Ill.). Phys. Rev., 131: 1249-50(Aug. 1, 1963).

A lower limit to the alpha half life of Cm^{247} was previously reported as 4×10^7 yr, but the determination reported here, with a curium sample containing 30 times more Cm^{247}, yields a half life of $(1.64 \pm 0.24) \times 10^7$ yr. This result implies that no detectable amount of primordial Cm^{247} exists on earth and that Cm^{247} could not account for the high U^{235}:U^{238} ratios reported for certain minerals. (auth)

31506 ALPHA-PARTICLE REACTION CROSS SECTION AT 40 Mev. G. Igo and B. D. Wilkins (Univ. of California, Berkeley). Phys. Rev., 131: 1251-3(Aug. 1, 1963).

The nonelastic cross section σ_R for 40-Mev alpha particles for 19 target elements ranging in atomic weight A between 9 and 232 was measured. The results have been compared with the predictions of the optical model σ_I. The ratio σ_R/σ_I deviates from unity in a systematic fashion being less than 1 for the lightest elements and greater than 1 for the heaviest. Superimposed on this trend, σ_R/σ_I dips by 18% for elements where the nuclear charge is near 28. A similar effect had been noted earlier in proton-reaction cross-section data but not in deuteron-reaction cross-section data. (auth)

31507 ELASTIC SCATTERING OF OXYGEN IONS BY CARBON, MAGNESIUM, AND ALUMINUM. J. A. Kuehner, E. Almqvist, and D. A. Bromley (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 131: 1254-9(Aug. 1, 1963).

Elastic scattering measurements have been carried out on the O + C, O + Mg, and O + Al systems using beams of O^{16} ions of precisely defined energy from the Chalk River tandem accelerator. Measurements have been made for energies near and above the Coulomb barrier appropriate to each system. Evidence for sharp (Γ ~ 300 kev) resonance structure is contained in a yield curve for O + C at a center-of-mass angle of 90°. This evidence is used to estimate $\Gamma_{elastic}/\Gamma$ for the resonant states to be ~7–10%. It is suggested that the resonant states involved may be similar to the "quasimolecular" states postulated to play an important role in the case of C + C scattering, although their appearance only at energies well above the Coulomb barrier, in contrast to the situation in C + C scattering, may allow a more conventional explanation. In the case of angular distributions for O + C, but not for O + Mg and O + Al, well-developed diffraction structure is observed. It is found that the simple sharp-cutoff models do not account quantitatively for the data although they do give the same qualitative features. (auth)

31508 INTERNAL PAIRS FROM ALIGNED NUCLEI. M. E. Rose (Univ. of Virginia, Charlottesville). Phys. Rev., 131: 1260-4(Aug. 1, 1963).

The problem of pair emission from light nuclei where the emitting state is oriented is examined. More specifically, as long as the polarization of neither member of the pair is observed, only nuclear alignment plays a role. Detailed plane wave calculations presented for the pure magnetic multipole show that if the dihedral angle between the planes of the alignment axis and recoil momentum and the plane of the pair is summed over, the distribution of pairs is the product of the unaligned distribution and the angular distribution of spin-one particles (photons). The ratio of pairs with fixed angle between the two members and fixed angle between the alignment and recoil directions to the number of photons with the latter angle also fixed is independent of alignment. For electric transitions the cor-

responding pair distribution is an incoherent sum of transverse and longitudinal parts. The first part, with nuclear orientation, is again multiplied by the spin-one angular distribution function but the longitudinal part is multiplied by a spin-zero angular distribution function. Hence, alignment will influence the ratio of pair and photon angular distributions because of the presence of the longitudinal field in the electron-nucleus interaction. (auth)

31509 COULOMB SELF-ENERGY OF AXIAL FIGURES. Robert Beringer (Yale Univ., New Haven). Phys. Rev., 131: 1402-6(Aug. 15, 1963).

A new method of computing the Coulomb self-energy of uniform axial figures is developed. The energy is expressed as a sum of slice-slice interactions plus the self-energy of each slice. Analytical formulas are derived for these energies and are presented in numerical tables. The method is tested numerically by comparing its results with the exact self-energies of certain simple figures. (auth)

31510 HYPERFINE STRUCTURE OF ERBIUM-169. Walter M. Doyle and Richard Marrus (Univ. of California, Berkeley). Phys. Rev., 131: 1586-8(Aug. 15, 1963). (UCRL-10571)

The hyperfine structure of radioactive Er^{169}($T_{1/2}$ = 9.4 days) has been studied in the $^3H_6$ electronic ground state by the atomic-beam magnetic-resonance method. The apparatus used was of sufficient accuracy to measure the nuclear dipole moment directly through its interaction with the external magnetic field. The results are A = 725.46(31) Mc/sec, g_J = −1.16381(5), and g_I = +5.55(27) × 10^{-4}, where A is the magnetic dipole interaction constant and the electronic and nuclear g factors, g_J and g_I, are given in units of Bohr magnetons. The nuclear magnetic moment inferred from g_I and corrected for diamagnetic shielding is μ_I = +0.513(25) nm. This value of μ_I is consistent with that obtained from A using the $\langle 1/r^3 \rangle$ value given by Lindgren. (auth)

31511 BETA DECAY OF B^{12}. David E. Alburger (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 131: 1624-32(Aug. 15, 1963). (BNL-6903)

The 3.23-Mev gamma-ray transition between the 7.66- and 4.43-Mev states of C^{12} has been observed in the beta decay of B^{12} by means of scintillation detectors and coincidence techniques. The B^{12} activity was made by the $B^{11}(d,p)B^{12}$ reaction using a Van de Graaff accelerator and a beam-chopping system for irradiation and delayed counting. All parts of the target-collimator assembly were constructed of beryllium in order to minimize bremsstrahlung production. Beta rays were detected in an 8-in.-diam by $\frac{1}{4}$-in.-thick Pilot-B scintillator and gamma rays were detected in two 5-in. × 5-in. NaI counters placed on opposite sides of the source. Gamma-gamma coincidence measurements were made by displaying the output of each NaI detector in coincidence with a channel centered on the full-energy-loss peak of 4.43-Mev gamma rays in the opposite NaI detector. The additional requirement of a coincidence with the beta-ray detector was imposed for beta-gamma-gamma coincidence experiments. In both types of measurements the full-energy-loss and one-escape peaks of the 3.23-Mev gamma rays were observed. Based on the average result of two previous nuclear reaction measurements of the fractional decay of the 7.66-Mev state by the emission of 3.23-Mev gamma rays, the present observation of these gamma rays leads to a value of (1.7 ± 0.5)% for the beta-ray branching of B^{12} to the 7.66-Mev state of C^{12}. (auth)

31512 STUDY OF THE $C^{12}(d,p)C^{13}$ REACTION MECHANISM: POLARIZATION AND (d,pγ) CORRELATIONS. J. E. Evans, J. A. Kuehner, and E. Almqvist (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 131: 1632-41(Aug. 15, 1963).

Measurements in the deuteron energy range 5.5 < E_d < 12 Mev have been made as follows on the reaction $C^{12}(d,p)C^{13*}$: (a) differential cross sections for protons to C^{13} ground state and C^{13*} (3.09 Mev) as functions of angle and energy; (b) proton polarization to C^{13} ground state and C^{13*} (3.09 Mev) as functions of energy at 45° (lab system) and as functions of angle (10° to 120° lab) for protons to 3.09-Mev state at E_d / 8.3, 9, and 10 Mev; and (c) proton-gamma correlation measurements with the gamma-ray detector on the normal to the reaction plane for reactions to C^{13*} (3.68 Mev) and C^{13*} (3.85 Mev). In (b) and (c) a double-focusing magnetic spectrometer selected the proton group in question; the polarization of the selected protons was measured by observing the "left-right" asymmetry from a carbon scatterer. Backgrounds were made negligible in the polarization work by coincidence methods. All the data show fluctuations with deuteron energy throughout the energy range studied; these fluctuations are attributed to compound-nucleus effects which invalidate a distorted-wave Born approximation (DWBA) stripping interpretation of results at isolated energies although direct interaction is the predominant mechanism. It is shown by taking average values over a wide energy range (~4 Mev) that a DWBA stripping description of the direct-interaction part of the reaction almost certainly will require the use of spin-dependent potentials. (auth)

31513 PROTON POLARIZATION IN THE REACTION $O^{16}(d,p)O^{17*}$ (0.87 Mev). J. E. Evans (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 131: 1642-3 (Aug. 15, 1963).

The polarization of protons following the $O^{16}(d,p)O^{17*}$ (0.87 Mev) reaction (l_n = 0) has been measured over the angular range 15° ≤ θ_p ≤ 110° at E_d = 7, 8.2, and 9.55 Mev and at 15° and 30° at several energies in the range 6.5 Mev ≤ E_d ≤ 9.55 Mev. Large polarizations are observed which are practically independent of deuteron energy; this fact suggests that the polarization arises from a direct interaction mechanism. The results imply that spin-dependent distortions will be required in any distorted-wave stripping description of this reaction. (auth)

31514 THRESHOLD EFFECTS IN NEUTRON ELASTIC SCATTERING. J. T. Wells, A. B. Tucker, and W. E. Meyerhof (Stanford Univ., Calif.). Phys. Rev., 131: 1644-60(Aug. 15, 1963).

In an attempt to observe the Wigner-cusp phenomenon in neutron elastic scattering near inelastic thresholds, the differential elastic and total cross sections of Li, Fe, Zr, Ba, and Ce near the threshold energy for exciting the first-excited states of the dominant isotopes of these elements were measured. The energy region investigated extended approximately 300 kev on either side of threshold. Successful analysis of observed cusp phenomena can provide information on the spin and parity of excited states. In addition, the presence or absence of below-threshold effects in regions of neutron energy and atomic number where "energy-averaged" Wigner-cusp theory applies in principle can give an indication of the interaction mechanism, i.e., direct interaction or compound nucleus formation. The theory of Wigner cusps and "energy-averaged" Wigner cusps is supplemented in the present work by a consideration of slightly more general angular-momentum situations and by explicit cusp expressions for differential-elastic cross sections. Cusp predictions are given in terms of the coefficients for expansion of the cross sections into a

studied using a 4π positron-scintillation spectrometer. The experimental shape factor exhibits a small systematic deviation from that theoretically predicted for an allowed transition and corresponds to an excess of low-energy positrons. The experimental shape factor can be fit by a curve proportional to (1 + b/W) with b = 0.3. The Fermi-Kurie plot is linearized by this correction factor and yields an end-point energy of 474 ± 5 kev. Similar discrepancies between the experimental and theoretically predicted shapes of Gamow-Teller beta transitions for negatrons (In^{114}, P^{32}, and Y^{90}) and positrons (Na^{22}) have been reported. In these cases it was found that this same shape factor with 0.2 < b < 0.4 would linearize the theoretically-corrected Fermi-Kurie plots. No satisfactory explanation for this effect has been offered. As previously suggested by other investigators, the shape factor (1 + b/W) must, for the present, be regarded as a purely empirical correction. The end-point energy from the present investigation combined with the recent high-precision measurement of the gamma-ray transition energy from the first excited state to the ground state of Fe^{58} yields a Co^{58}-Fe^{58} mass difference of 2306 ± 5 kev. (auth)

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31512 STUDY OF THE $C^{12}(d,p)C^{13}$ REACTION MECHANISM: POLARIZATION AND (d,pγ) CORRELATIONS. J. E. Evans, J. A. Kuehner, and E. Almqvist (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 131: 1632-41(Aug. 15, 1963).

Measurements in the deuteron energy range $5.5 < E_d < 12$ Mev have been made as follows on the reaction $C^{12}(d,p)C^{13*}$: (a) differential cross sections for protons to C^{13} ground state and C^{13*} (3.09 Mev) as functions of angle and energy; (b) proton polarization to C^{13} ground state and C^{13*} (3.09 Mev) as functions of energy at 45° (lab system) and as functions of angle (10° to 120° lab) for protons to 3.09-Mev state at E_d / 8.3, 9, and 10 Mev; and (c) proton-gamma correlation measurements with the gamma-ray detector on the normal to the reaction plane for reactions to C^{13*} (3.68 Mev) and C^{13*} (3.85 Mev). In (b) and (c) a double-focusing magnetic spectrometer selected the proton group in question; the polarization of the selected protons was measured by observing the "left-right" asymmetry from a carbon scatterer. Backgrounds were made negligible in the polarization work by coincidence methods. All the data show fluctuations with deuteron energy throughout the energy range studied; these fluctuations are attributed to compound-nucleus effects which invalidate a distorted-wave Born approximation (DWBA) stripping interpretation of results at isolated energies although direct interaction is the predominant mechanism. It is shown by taking average values over a wide energy range (~4 Mev) that a DWBA stripping description of the direct-interaction part of the reaction almost certainly will require the use of spin-dependent potentials. (auth)

31513 PROTON POLARIZATION IN THE REACTION $O^{16}(d,p)O^{17*}$ (0.87 Mev). J. E. Evans (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 131: 1642-3 (Aug. 15, 1963).

The polarization of protons following the $O^{16}(d,p)O^{17*}$ (0.87 Mev) reaction ($l_n = 0$) has been measured over the angular range $15° \leq \theta_p \leq 110°$ at $E_d = 7$, 8.2, and 9.55 Mev and at 15° and 30° at several energies in the range 6.5 Mev $\leq E_d \leq$ 9.55 Mev. Large polarizations are observed which are practically independent of deuteron energy; this fact suggests that the polarization arises from a direct interaction mechanism. The results imply that spin-dependent distortions will be required in any distorted-wave stripping description of this reaction. (auth)

31514 THRESHOLD EFFECTS IN NEUTRON ELASTIC SCATTERING. J. T. Wells, A. B. Tucker, and W. E. Meyerhof (Stanford Univ., Calif.). Phys. Rev., 131: 1644-60(Aug. 15, 1963).

In an attempt to observe the Wigner-cusp phenomenon in neutron elastic scattering near inelastic thresholds, the differential elastic and total cross sections of Li, Fe, Zr, Ba, and Ce near the threshold energy for exciting the first-excited states of the dominant isotopes of these elements were measured. The energy region investigated extended approximately 300 kev on either side of threshold. Successful analysis of observed cusp phenomena can provide information on the spin and parity of excited states. In addition, the presence or absence of below-threshold effects in regions of neutron energy and atomic number where "energy-averaged" Wigner-cusp theory applies in principle can give an indication of the interaction mechanism, i.e., direct interaction or compound nucleus formation. The theory of Wigner cusps and "energy-averaged" Wigner cusps is supplemented in the present work by a consideration of slightly more general angular-momentum situations and by explicit cusp expressions for differential-elastic cross sections. Cusp predictions are given in terms of the coefficients for expansion of the cross sections into a

series of Legendre polynomials. This form facilitates comparison of theory and experiment. Unusual features were observed at the inelastic thresholds in the elastic and total cross sections of Li and Fe. Here one expects to notice a below, as well as above, threshold effect characteristic of Wigner cusps. In these cases, however, the interpretation of the experimental results is not unambiguous—in Li because the predicted cusp effect is too small to be observable in the present experiment and in Fe because the resonance structure of the cross sections overshadows the expected cusp effect. A drop, commencing at inelastic thresholds, is observed in the elastic cross sections of Ce, Ba, and Zr. Analysis of this effect in terms of the theory of "energy-averaged" Wigner-cusps yields good agreement between theory and experiment. (auth)

31515 STUDY OF THE $F^{19}(p,\alpha_0)O^{16}$ REACTION WITH 3- TO 12-Mev PROTONS. K. L. Warsh, G. M. Temmer, and H. R. Blieden (Florida State Univ., Tallahassee). Phys. Rev., 131: 1690-6(Aug. 15, 1963).

The reaction $F^{19}(p,\alpha_0)O^{16}$ was studied with 3- to 12-Mev protons. Angular distributions were measured at 23 energies. Excitation curves were measured at 70 and 165° over wide energy ranges. The angular distributions show a great variety of shapes, with combinations of forward and backward peaking. The excitation curves have considerable structure, but the structure is not fine enough to be interpreted as individual compound-nucleus levels. Direct-reaction analysis of the angular distributions was only partially successful, indicating that the reaction mechanism is more complicated. (auth)

31516 EMISSION OF Be^7 AND COMPETITION PROCESSES AT 30 to 42 Mev. Edward F. Neuzil and Richard H. Lindsay (Western Washington State Coll., Bellingham). Phys. Rev., 131: 1697-1701(Aug. 15, 1963).

A study has been made of cross sections for the reactions $Al^{27}(p,Be^7)$ at 30 to 39 Mev; $V^{51}(p,Be^7)$ at 33 to 39 Mev; $V^{51}(He^4,Be^7)$ and $V^{51}(He,He^4He^3)$ at 40 Mev; $Co^{59}(He^4,Be^7)$ and $Co^{59}(He^4,He^4He^3)$ at 36 to 41 Mev; and $Ni(He^4,Be^7)$ at 33 to 41 Mev. The cross sections for the competing modes of Be^7 and $He^4 + He^3$ emission are found to be of the same order of magnitude in V^{51} at bombarding energies where these modes alone can compete in the emission of 7 amu. Significantly different results were obtained with the Co^{59} target where $He^4 + He^3$ emission is favored by a factor of 6 or 7 over Be^7 emission. He-ion and proton-induced reactions leading to the same compound nucleus with subsequent emission of Be^7 show that the (He^4,Be^7) reaction has a somewhat higher cross section at equivalent excitations of the compound nuclei. Cross sections for other He-ion-induced reactions with V^{51} and Co^{59} involving multicluster alpha emission are reported. (auth)

31517 STUDIES OF ALPHA PARTICLES FROM THE $Li^6 - Li^6$ NUCLEAR REACTION. Minao Kamegai (Univ. of Chicago). Phys. Rev., 131: 1701-11(Aug. 15, 1963).

The reaction mechanism and the states in Be^8 in a Li^6-induced reaction $Li^6(Li^6,\alpha)Be^8 \rightarrow 3\alpha$ were studied by a double coincidence experiment in which angles and energies of the two simultaneous alphas were recorded. The bombarding energy was 1.9 Mev. When the data are transformed to the center-of-mass system, it is shown that a mechanism in which the entire available energy is divided equally between two alphas emitted 180° apart is some 23 times more probable than one in which one of the alphas recoils from Be^8 in its ground state. There are also satellite coincidence maxima at 169° and 192°. The pattern can be interpreted as due to a cluster reaction mechanism in which Li^6 combines with a deuteron cluster to produce a state of Be^8 at 20.95 ± 0.3 Mev which is $(Li^6 + d)$-like. The pattern is fitted best, if a Breit-Wigner probability distribution for the excited Be^8 state is assumed, by a total width of 3.4 Mev. It is estimated that the α-decay width of this state is 260 ± 90 kev. Such a mechanism has previously been suggested by Coste and Marquez, following ideas of Temmer. The angular distribution of the alpha group which leaves Be^8 in its ground state is nearly isotropic in the barycentric system. It seems that the reaction leading to the ground state of Be^8 proceeds through an intermediate compound nucleus, C^{12*}. The absolute total cross section for an intermediate stage involving the ground state of Be^8 is 5.8×10^{-29} cm^2; for the 20.85 Mev state it is 13×10^{-28} cm^2. (auth)

31518 LOW-ENERGY STATES IN Y^{90}. Yeong E. Kim (Univ. of California, Berkeley). Phys. Rev., 131: 1712-22 (Aug. 15, 1963). (UCRL-10329)

The low-energy levels of the odd-odd nucleus Y^{90} are calculated with finite-range central and tensor forces to first order by means of the j-j coupled odd-group model. The two-body matrix elements for the central and tensor forces are expressed in the j-j representation, from which a generalization to off-diagonal matrix elements is obtained in the limit of the zero range. A phenomenological Gaussian potential without a hard core, estimated from the free two-nucleon potentials of Jackson-Blatt and Brueckner-Gammel-Thaler, is used for the residual interaction. The effects of the tensor force are analyzed in detail as a function of the force range. The numerical results of the calculation are in reasonably good agreement with available experimental spectra. (auth)

31519 REACTION $Na^{23}(p,\alpha)Ne^{20}$ FOR PROTON BOMBARDING ENERGIES FROM 100 TO 450 Kev. T. R. Fisher and W. Whaling (California Inst. of Tech., Pasadena). Phys. Rev., 131: 1723-6(Aug. 15, 1963).

The $Na^{23}(p,\alpha)Ne^{20}$ reaction has been studied for proton bombarding energies in the range 100 to 450 kev. Four narrow resonances were observed at proton bombarding energies E_p = 286, 338, 374, and 445 kev. Excitation functions were taken at each of these resonances, and the alpha yield, width, and resonance energy were determined for each resonance. On the basis of angular distribution measurements, spin and parity assignments have been made for the resonances at E_p = 286, 338, and 374 kev. Upper limits have been established for the nonresonant cross-section factor S and for the alpha yield from resonances not observed. The $Na^{23}(p,\alpha)Ne^{20}$ reaction rate in stars is computed for temperatures $(5-10) \times 10^8$ °K, the temperature range in which carbon burning takes place. (auth)

31520 ABSOLUTE CROSS SECTIONS AND EXCITATION FUNCTIONS FOR (d,p) AND (d,2n) REACTIONS ON Mn^{55}, Cu^{63}, Cu^{65}, Zn^{66}, AND Zn^{68} BETWEEN 3 AND 11.6 Mev. L. J. Gilly, G. A. Henriet, M. Preciosa Alves, and P. C. Capron (Université, Louvain, Belg.). Phys. Rev., 131: 1727-31(Aug. 15, 1963).

Absolute cross sections and excitation functions for some (d,p) and (d,2n) reactions have been measured by activation and stacked-foil techniques. The cross sections for (d,p) reactions seem to indicate a direct mechanism, although there seems to be some compound nucleus admixture above the Coulomb barrier. A striking result is the great difference (a factor 3.5) between the (d,p) cross sections on the two Cu isotopes. This result is unexplained and requires confirmation. The (d,2n) reaction proceeds

via compound-nucleus formation but the theoretical excitation functions, calculated on the basis of compound-nucleus formation followed by evaporation of particles, are not in agreement with the experimental ones. The isomeric ratio of the Zn^{69} isomers is also discussed. (auth)

31521 CONTRIBUTION TO THE THEORY OF COULOMB STRIPPING. A. Dar, A. de-Shalit, and A. S. Reiner (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 131: 1732-9(Aug. 15, 1963).

The theory of deuteron stripping for incident deuteron energies below the Coulomb barrier is presented for proton-neutron interaction of finite range. Reasonable approximations valid only for the conditions prevailing in the case of Coulomb stripping enable factorization of the transition amplitude in analytic form. The results account for observed regularities and explain the discrepancy between experiment and a theory based on zero-range nuclear forces. Stripping with associated Coulomb excitation is shown to be a competing process for sufficiently low deuteron energy. The reaction enables excitation of a new class of excited states. It should in particular yield information about the alleged multiplet structure of low-lying states of odd-A nuclei, of which the even-even neighbors show vibrational spectra. Angular distributions of outgoing protons resulting from stripping on targets with $J_i \geq 1$ may yield information about static quadrupole moments of those nuclei. The contribution of the polarizability of the deuteron to the differential cross sections is shown to be negligible. (auth)

31522 DECAY OF THE 25-MIN ACTIVITY OF Te^{131}. S. H. Devare, P. N. Tandon, and H. G. Devare (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 131: 1750-5(Aug. 15, 1963).

The decay of the 25-min activity of Te^{131} has been investigated with scintillation spectrometers and also with an intermediate image beta-ray spectrometer. The energies of the gamma rays which have been observed are 145, 350, 445, 490, 590, 650, 930, 985, 1130, and 1280 kev. On the basis of gamma-gamma coincidence measurements, it is proposed that the 350-, 930-, and 985-kev gamma rays are doublets of gamma rays with energies close to each other. The observed coincidences are explained by proposing levels at 145, 490, 590, 1065, 1130, 1425, and 1480 kev. The total absorption gamma-ray spectrum and sum-coincidence spectra have also been studied to confirm these levels and their decay modes. Spin and parity assignments have been made to these levels on the basis of the log ft values of the beta transitions feeding them and also their decay modes. (auth)

31523 EFFECT OF EXCHANGE ON M/L ELECTRON CAPTURE RATIOS. John N. Bahcall (California Inst. of Tech., Pasadena). Phys. Rev., 131: 1756-9(Aug. 15, 1963).

Theoretical expressions that include the effect of electron exchange are given for M/L electron-capture ratios; the results are presented in a form that makes clear the physical origin of the exchange corrections. Accurate values for M/L ratios both with and without exchange corrections are tabulated for Z between 13 and 37; these numerical results were calculated using the analytic Hartree-Fock wave functions of Watson and Freeman. The exchange correction for Z greater than or equal to 38 has been estimated by a least squares extrapolation of the correction for lower Z values. The effect of electron exchange on electron capture to positron emission ratios is also discussed. The exchange-corrected theoretical M/L ratio for $_{32}Ge^{71}$ is 0.173, in disagreement with the recent measurement of Manduchi and Zannoni. It is suggested that some additional precision measurements of M/L ratios be performed in order to clarify this discrepancy between theory and experiment. (auth)

31524 NUCLEAR REACTION ENERGIES WITH AN ABSOLUTE ION VELOCITY GAUGE. B. R. Gasten (Univ. of Wisconsin, Madison). Phys. Rev., 131: 1759-64(Aug. 15, 1963).

A time-of-flight technique was used to find the $Li^7(p,n)Be^7$ threshold energy and an $Al^{27}(p,\gamma)Si^{28}$ resonant energy. Results place the $Li^7(p,n)$ threshold at 1879.8 ± 0.3 kev and the $Al^{27}(p,\gamma)$ resonance at 991.6 ± 0.2 kev. The lithium threshold was determined by use of a $(\text{yield})^{\frac{1}{3}}$ extrapolation. The aluminum resonant energy is taken as the half-height energy of a thick-target yield. Except for the earliest electrostatic analyzer results, there was good agreement with previous determinations of these energies. The proton beam was modulated at approximately 50 Mc/sec by use of an Einzel lens driven by a crystal controlled oscillator-amplifier at the ion source of an electrostatic accelerator. The time-of-flight equipment consisted of a drift tube of adjustable length, a "phase meter" employing a variable delay line, and two pickups consisting of tuned cylindrical tubes through which the proton beam passed. Frequency was measured by zero beating a variable-frequency crystal oscillator against the signal picked off the beam and counting the crystal frequency with a frequency counter standardized to WWV. The lithium and aluminum targets were protected from organic vapors by a concentric liquid nitrogen trap. (auth)

31525 EJECTION OF LARGE FRAGMENTS IN HIGH-ENERGY NUCLEAR REACTIONS. Vitor P. Crespo, John M. Alexander, and Earl K. Hyde (Univ. of California, Berkeley). Phys. Rev., 131: 1765-81(Aug. 15, 1963). (UCRL-10496)

The formation cross section for Na^{24} and Mg^{28} was measured in targets of Cu, Ag, Au, and U bombarded with protons and helium ions over the energy range 320 to 880 Mev. In addition, the kinetic energy of these products was measured by a thick-target, recoil-range technique at incident proton energies of 0.7 and 3.0 Bev and an incident helium ion energy of 0.88 Bev. In both sets of properties there was found a close similarity in the results from helium ion and proton bombardments. In the case of the proton bombardments the results were compared to the predictions of the conventional model of high-energy regions, i.e., a fast nucleonic cascade followed by a slower evaporation cascade. It was found that the conventional model cannot reproduce the results, which suggests that another reaction mechanism, fragmentation, is required. Possible views of a fragmentation mechanism are presented, and the implications of the experimental results for the nature of the fragmentation mechanism are explored. (auth)

31526 LOW-ENERGY INTRANUCLEAR CASCADE CALCULATION. Hugo W. Bertini (Oak Ridge National Lab., Tenn.). Phys. Rev., 131: 1801-21(Aug. 15, 1963).

Monte Carlo cascade calculations have been performed for nuclear reactions involving incident protons, neutrons, π^+, and π^- on complex nuclei. The upper energy limit of validity of the calculation is ≈350 Mev below which pion production is not likely. In order to determine the effects of a diffuse nuclear edge, calculations were performed both for nucleon-density distributions within the nucleus which approximated the charge distribution obtained from electron-scattering data and for constant-density distribu-

tions. The results indicate that the bulk of the effect in going from a uniform to nonuniform nucleon-density distribution is due to the increased nuclear size when a diffuse edge is used, while the effects due to the diffuse edge alone are of second order. The limits of application of the general model have been investigated and are discussed. (auth)

31527 ELECTROMAGNETIC STRUCTURE OF THE GIANT DIPOLE RESONANCE. F. H. Lewis, Jr., J. D. Walecka, J. Goldemberg, and W. C. Barber (Stanford Univ., Calif.). Phys. Rev. Letters, 10: 493-5(June 1, 1963).

Form factors for the giant resonance in C^{12} (excited by inelastic electron scattering) were calculated by a shell model and collective models. The cross section as a function of scattered electron energy was measured for 55-Mev electrons on C^{12}. The shell model was found to give the form factor observed experimentally, while the collective models were completely inadequate. (D.C.W.)

31528 MEASUREMENT OF SPINS OF SOME STATES IN Ca^{41}. L. L. Lee, Jr., J. P. Schiffer, and D. S. Gemmell (Argonne National Lab., Ill.). Phys. Rev. Letters, 10: 496-8(June 1, 1963).

The proton-gamma angular correlation following the Ca^{40} (d,p) reaction going to the 2.47 and 3.95-Mev excited states was measured. The spins of the two states were concluded to be $\frac{3}{2}^-$ and $\frac{1}{2}^-$, respectively. This result is contrary to that expected from a study of the systematics of low-lying states in even-Z, odd-N nuclei for $41 \leq A \leq 61$. (D.C.W.)

31529 MEASUREMENT OF THE μ^- CAPTURE RATE IN He^3. Leonard B. Auerbach, Robert J. Esterling, Roger E. Hill, David A. Jenkins, Joseph T. Lach, and Norman H. Lipman (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 23-6(July 1, 1963). (UCRL-10836)

The rate was measured to an accuracy of a few percent, using high-pressure He^3 gas both as a target and as a scintillation detector for the recoil triton. The measured rate (average value, 1520 ± 50 sec^{-1}) agrees quite well with the 1450 sec^{-1} obtained on the basis of the universal Fermi interaction. (D.C.W.)

31530 AN ISOMERIC STATE IN ^{102}Rh. P. Born, A. Veefkind, W. H. Elsenaar, and J. Blok (Vrije Universiteit, Amsterdam). Physica, 29: 535-6(May 1963).

Measurements on the decay of Rh^{102} indicate transitions from an isomeric state ($T_{1/2}$ = 1057 days) to the 2220 and 1870 kev levels in Ru^{102}. For the spins of the states of Rh^{102}, 3 or 4 ($T_{1/2}$ = 1057 days) and 0 or 1 ($T_{1/2}$ = 205 days) are proposed. (auth)

31531 ANGULAR CORRELATIONS IN ^{102}Ru. P. Born, H. A. J. van der Kamp, W. H. Elsenaar, and J. Blok (Vrije Universiteit, Amsterdam). Physica, 29: 537-42(May 1963).

Angular correlation measurements of gamma ray cascades in the decay of Rh^{102} give the following values for the spins: 2^+(474.8 kev); 2^+(1103.3 kev); 4^+(1106.4 kev); 3^+(1525 kev); 0^+(1840 kev); 3, 4, or 5(1870 kev); 2(2040 kev); and 3(2220 kev). (auth)

31532 DIAGRAMS FOR CALCULATION OF PARTICLE ELASTIC INTERACTIONS. Yu. I. Serebrennikov (Leningrad Polytechnical Inst.). Pribory i Tekhn. Eksperim., No. 2, 169-71(Mar.-Apr. 1963). (In Russian)

A scattering diagram for elastic reactions is presented. The diagram is composed of several semicircles that depend on the particle parameters of momentum and kinetic energy for their particular geometries. The diagram lies entirely in one plane. For relativistic particles the geometry is transformed to semi-ellipses. A diagram representing proton elastic scattering from helium-4 nuclei is illustrated. (C.E.S.)

31533 SYSTEMATICS OF SOME BETA-TRANSITIONS. S. M. Brahmavar and M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Proc. Indian Acad. Sci., Sect. A, 57: 275-9(May 1963). (In English)

In order to throw some light on the mechanism of excitation of 0^+ excited states of even-even nuclei, the log (ft) values for beta-transitions to the 0^+ excited state and the 0^+ ground state of even-even nuclei were compared. In this analysis both allowed and forbidden beta-transitions were considered. This survey is similar to that of beta-transitions by M. Sakai. Results of the present analysis are presented and compared to that of Sakai. (auth)

31534 ENERGY LEVELS OF Mg^{26} FROM THE DECAY OF Al^{26}. M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Proc. Indian Acad. Sci., Sect. A, 57: 311-14(May 1963). (In English)

Gamma rays accompanying the decay of long-lived Al^{26} were studied by means of coincidence scintillation spectrometry. A level scheme for Mg^{26} was proposed in essential agreement with earlier results. (auth)

31535 REDUCED WIDTHS OF LEVELS IN SHARP RESONANCE REGION AND CALCULATION ON Si^{28} + P. Akira Fukuhara (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 29: 550-61(Apr. 1963). (In English)

An attempt is made to interpret the smallness of the reduced widths of some isolated resonance levels observed in the reaction processes of the lighter nuclei. Resonance scattering of a proton by Si^{28} is discussed as an example, and it is found out that the small relative reduced width of the order of magnitude $\theta^2 = 10^{-2} - 10^{-3}$ of the process may be successfully interpreted by a relatively simple model. Namely, the incident proton drops into a bound orbit, inducing simultaneously an excitation of the target nucleus and subsequent reemission of the proton, leaving the target nucleus again in the ground state. (auth)

31536 ON A POSSIBLE METHOD DESCRIBING THE NUCLEAR ROTATIONAL MOTION. Yoshiyuko Shono (Hokkaido Univ., Sapporo, Japan). Progr. Theoret. Phys. (Kyoto), 29: 562-73(Apr. 1963). (In English)

A possible way of describing the nuclear rotational motion on the basis of a system with a deformed average potential well is examined. As a simple example, the two dimensional Q-Q interaction model is analyzed. Following Lipkin, an operator that generates the rotational motion is introduced. Using this operator rotational states in the deformed potential system are redefined, and, at the same time, time dependent wave functions are introduced. It is shown that the system thus obtained gives a physical basis to the cranking model. (auth)

31537 ON p-He^4 EFFECTIVE POTENTIAL AND NUCLEAR FORCES. Hiroyuki Kaneda, Sinobu Nagata, Shoichiro Otsuki, and Yoshio Sumi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 29: 610-12(Apr. 1963). (In English)

The p-He^4 elastic scattering around 40 Mev where the d and f-wave effects are not negligible is discussed. An effective p-He^4 potential is constructed from a standard nucleon-nucleon potential. The radial part of the Schroedinger equation for the interacting system with orbital and total angular momenta is presented. The effective potentials have strong orbital angular momentum dependence. This is a direct consequence of the antisymmetry among nucleons and the exchange character of the nuclear forces. The central and spin-orbit coupling parts of the

effective potential at 40 Mev are given. The d and p-wave phase shifts and polarization measurements are also presented. (C.E.S.)

31538 MEASUREMENT OF THE HALF LIFE OF THE FIRST EXCITED STATE OF F^{19} BY THE METHOD OF DELAYED COINCIDENCES. M. Vázquez, C. Tagueña, and V. C. de la Peña (Universidad Nacional de Mexico). Rev. Mex. Fis., 12: 27-41(1963). (In Spanish)

The lifetime of the first excited state of F^{19} was measured by the method of delayed coincidences. The prompt coincidence curve was obtained with an Al^{27} target. The F^{19} target was prepared by evaporation of lead fluoride on tantalum backing. A B^{10} target was also used to test and calibrate the equipment. The lifetime of the first excited state of B^{10} was measured several times and these results agreed satisfactorily. Therefore, the B^{10} lifetime of 1×10^{-9} sec was as a calibration standard for the time axis, the observed shift of the centroid of the delayed coincidence curve corresponds to this value. The F^{19} targets were bombarded with 1.5-Mev protons, and a shift corresponding to a lifetime of $(0.87 \pm 0.14) \times 10^{-9}$ sec was obtained. This measurement seems to be somewhat lower than previously reported values, and the present standard deviation is also smaller. (auth)

31539 ELASTIC AND INELASTIC SCATTERING OF DEUTERONS ON Sr, Zr, Nb, Pd, AND Ag AT 11.8 Mev. W. Lorenz, U. Schmidt-Rohr, and O. Vater (Max-Planck-Institut für Kernphysik, Heidelberg). Z. Physik, 174: 326-36(1963). (In German)

Continuing previous experiments on the elastic and inelastic scattering of 11.8-Mev deuterons on the medium-weight nuclei Sr, Zr, Nb, Pd, and Ag were studied. In addition to elastically scattered deuterons, angular distributions of inelastically scattered deuterons were obtained for one group in Sr, and three groups in Zr and Nb, respectively, between 20° and 165°. The correlation between the diffraction maxima is discussed in terms of Blair's phase rule. As in previous results, this rule works poorly in the comparison between elastic and inelastic angular distributions. However the strongly excited inelastic groups which are interpreted as collective vibrational states do follow this rule. In the case of Pd and Ag, energy spectra at several scattering angles were measured. The integrated differential cross sections of the inelastically scattered deuterons at $\Theta = 90°$ of all investigated elements were compared with those of previous measurements. They show the influence of closed shells but no systematic decrease or increase with increasing atomic weight. (auth)

31540 PHOTOPROTONS FROM CARBON, NITROGEN, OXYGEN, AND NEON. E. Finckh, R. Kosiek, K. H. Lindenberger, K. Maier, U. Meyer-Berkhout, M. Schechter, and J. Zimmerer (Universität, Heidelberg). Z. Physik, 174: 337-50(1963). (In German)

The energy spectra of photoprotons from carbon, oxygen, nitrogen, and neon were investigated with 30.5-Mev bremsstrahlung of the Heidelberg betatron using a CsI(Tl) spectrometer. The known resonances could be confirmed; new resonances were found in nitrogen. Yields and cross sections relative to those of the reaction $C^{12}(\gamma,n)C^{11}$ are given. (auth)

31541 ANGULAR CORRELATION MEASUREMENTS ON >30-yr Ho^{166} AND DETERMINATION OF THE g_R FACTORS OF THE 4+ ROTATION LEVEL OF Er^{166}. E. Gerdau, W. Krull, L. Mayer, J. Braunsfurth, J. Heisenberg, P. Steiner, and E. Bodenstedt (Universität, Hamburg). Z. Physik, 174: 389-404(1963). (In German)

The spins of several excited states of Er^{166} were investigated by $\gamma-\gamma$ angular correlation measurements. The spin sequence 0+, 2+, 4+, and 6+ for the ground state rotational band was presumed to be correct. Unique assignments were derived for the states of 1076, 1377, and 1785 kev as I = 5, 7, and 6 respectively. These results are in agreement with the spins proposed by Gallagher Jr. and Soloviev. The multipolarities of the γ transitions of 408, 709, 811, and 831 kev were derived as 95% E_1 + (5 ± 1)% M_2, 99.6% E_1 + (0.4 ± 0.5)% M_2, 99.1% E_2 + (0.0 ± 0.3)% M_1, and 96.1% E_2 + (3.9 ± 1)% M_1 respectively. The unusual mixing ratios of the transitions of 811 and 831 kev can be understood as a consequence of the K-selection rule. Each γ transition from the 1785 kev state should be strongly K-forbidden and a half life of $T_{1/2} \approx 3 \times 10^{-9}$ sec is expected. A measurement of the time spectrum of the coincidences between the β radiation and the high energy γ lines gave however: $T_{1/2}$(1785 kev state) $\leq 3 \times 10^{-10}$ sec. The rotation of the angular correlation between the 184 kev line and the γ group at 820 kev was measured in an external magnetic field of 53,000 gauss as: $\omega \cdot \tau(4+) = 0.083 \pm 0.006$. This value contains small corrections for an additional rotation of the angular correlation of the 831–184 kev triple cascade in the 6+ state and for a small attenuation by internal fields. With $T_{1/2}$(4+ state) = 1.23×10^{-10} sec, and $\beta = 7.08$, $g_R = +0.266 \pm 0.024$ was obtained in good agreement with recent results for the 2+ state. (auth)

31542 OPTICAL MODEL DESCRIPTION OF LOW ENERGY COLLISIONS BETWEEN HEAVY IONS. J. A. Kuehner and E. Almqvist (Atomic Energy of Canada Ltd., Chalk River, Ont.). 24p. (CONF-62-2)

From 3rd Conference on Reactions Between Complex Nuclei, Asilomar, Calif., Apr. 1963.

An optical model was used to describe the elastic scattering of $O^{16} + C^{12}$, $N^{14} + C^{12}$, and $N^{14} + Be^9$ for energies near and above the Coulomb barrier. Using a Woods-Saxon form for both the real and imaginary potentials, good agreement with the experimental data is obtained. Quantitative differences between $O^{16} + C^{12}$, which exhibits well-developed diffraction structure, and the other two systems, which exhibit less pronounced diffraction structure, are well accounted for by the model and are reflected mainly by the size of the imaginary potential, a small imaginary potential being associated with the large amplitude diffraction oscillations. The parameters determined by fitting the elastic scattering data yield reaction cross sections in agreement with measured data. Although the model gives a good description of the data there are difficulties in the physical interpretation. This arises from the deep interpenetration of the colliding ions implied by the model; for $O^{16} + C^{12}$, which requires a small absorption in order to fit the large diffraction oscillations, the mean-free-path inside the potential is ~6 fm. Such a deep interpenetration does not seem physically realistic, yet, within the framework of the model it appears to be a necessary condition for producing the observed amplitude of diffraction oscillations. (auth)

31543 SU3 REDUCTION COEFFICIENTS, FRACTIONAL PARENTAGE, AND PARTICLE REDUCED WIDTHS IN THE 2s-1d SHELL. K. T. Hecht (Univ. of Michigan, Ann Arbor). 46p. (CONF-22-8)

From American Physical Society, Annual Meeting, New York, Jan. 1963.

It is shown that fractional parentage coefficients (cfp) for some interesting intrinsic states of s-d nuclei can be calculated by developing the machinery for the computation of SU3 reduction coefficients. Explicit algebraic ex-

pressions are given for both the reduction (Wigner) coefficients and the recoupling (Racah) coefficients that are needed to compute the $\{n\{1n\text{-}1\}\}$ and $\{n\{1n\text{-}2\}\}$ cfp calculations of the cfp, which can be carried out without recourse to a full chain calculation, are illustrated by a few examples. The cfp are used to give expressions for single-particle reduced widths for 2s-1d shell nuclei. (auth)

31544 DYNAMIC NUCLEAR POLARIZATION IN LIQUID HELIUM THREE. Ned Stuart Vander Ven. Thesis, Princeton, N. J., Princeton Univ., 1962. 118p.

An attempt was made to produce a large enhancement of the nuclear polarization in liquid He^3 by dynamic mechanisms, the prototype of which was suggested by Overhauser. Materials in which intense spin resonances were observed, arising from large concentrations of unpaired electrons, were deliberately introduced into the He^3 sample tube, in the hope that the nuclear relaxation would then be dominated by dipolar interaction with the unpaired electron spins. A search was made for enhanced polarization arising from two different effects. One involved saturation of the allowed electronic transitions ($\Delta M_s = \pm 1$, $\Delta M_I = 0$), in which nuclear polarization is induced by relaxation by a fluctuating dipole interaction originating in the random thermal motions of the liquid. The other involved saturation of the forbidden electronic transitions ($\Delta M_s = \pm 1$, $\Delta M_I = \pm 1$; $\Delta M_s = \pm 1$, $\Delta M_I = \mp 1$), which become weakly allowed in the presence of a static dipolar coupling between the unpaired electrons and nuclei adsorbed on the surface of the paramagnetic material. Polarization was detected by monitoring the intensity of the nuclear resonance signal while saturating the electronic transitions, which were observed at a frequency of ≈9300Mc/sec; the corresponding He^3 nuclear resonance frequency was ≈11Mc/sec. Approximately 400 Mw of saturating power was available from the microwave spectrometer. No enhancement of the nuclear polarization was observed from either mechanism, either in the liquid between 1.2 and 3.2°K, or in the gas between 3.2 and 4.2°K, although saturation factors of 50 to 80% were attained; the intensity of the nuclear resonance signal remained constant, ±10%, at all levels of electronic saturation. The paramagnetic materials used were charred dextrose, DPPH adsorbed on powdered activated charcoal, small particles of Li metal, and the powdered pyrolized polymer PAQR. The spin-lattice relaxation time of the He^3 in the presence of these materials was remarkably long, varying from ≈1 second to ≈30 seconds. Failure to observe enhancement from a static dipolar coupling is presumed to arise from lack of adsorption of the He^3 on the paramagnetic surfaces. It is suggested that the absence of polarization from a fluctuating interaction is evidence for an inadequate Fourier spectrum of the fluctuating interaction at the microwave frequency, based on a random noise model. From the absence of enhancement a lower limit for the nucleus-electron correlation time is estimated to be $\tau_c \geq 6 \times 10^{-10}$ sec. Conditions are given for which a small enhancement of the polarization might be observed. (auth)

31545 A MAGNETIC ANALYSIS OF CHARGED PARTICLES FROM THE REACTIONS OF 15 Mev NEUTRONS WITH NICKEL. Lillian Darlington Singletary. Thesis, Evanston, Ill., Northwestern Univ., 1962. 134p.

The total cross section and energy spectrum for the (n,p) reaction on Ni was measured using a modified broad-range magnetic spectrograph with nuclear emulsions as detector. Proton spectra were measured at two angles, 0° and 138°. A nuclear temperature of 1 Mev was determined. Assuming an isotropic contribution due to the compound nucleus interaction, the cross section, due to this process, was found to be 650 ± 150 millibarns. The additional contribution due to direct interaction was estimated to be 160 ± 30 mb. An (n,α) cross section of 87 ± 45 mb was found. The limitation on accuracy was due to the statistics. An upper limit on the (n,d) cross section of 25 mb was determined. (auth)

31546 ALPHA DECAY OF NONAXIAL NUCLEI. Abul Kalam Rafiqullah. Thesis, Troy, N. Y., Rensselaer Polytechnic Inst., 1962. 131p.

A theory is developed, within the context of the Davydov-Filippov model of the nucleus, to describe the even-parity-alpha decay of nonaxial nuclei. In the Hamiltonian of the two body systems (alpha particle and the daughter nucleus) the operator for the energy of the nuclear vibrations and the rotational energy of the daughter nucleus are neglected. The resulting wave equation is then solved by means of the three-dimensional WKB-approximation method, together with the ray concept of optics. This involves, in part, an extremal problem analogous to Fermat's principle in optics, and amounts to solving a set of coupled differential equations determining the ray and requires numerical calculations. As a first approximation, the differential path of the ray in the spherically symmetric barrier is used to solve the extremal problem for the non-axial barrier, since the anisotropy of the potential is assumed to be small in comparison with its spherical part. In this way, an approximate formula for the wave-function describing the even-parity-alpha decay of a parent nucleus is obtained, and from the radial part of this function, formulas for transition probabilities of even parity alpha groups are derived. These formulas sensitively depend on the deformation parameter, β, shape parameter, γ, and the expansion coefficients, A_{K_f}, of the wave-function of the daughter nucleus describing the rotational states. Agreement between the theoretical and the empirical values of the reduced transition probabilities is obtained by assuming that the alpha wave function on the nuclear surface is given as an expansion in spherical harmonics, keeping up to only quadrupole terms. The two expansion coefficients thus introduced are determined from the empirical data. This amounts to setting the boundary by the empirical data. For even-even nuclei having $\gamma \leq 15°$ the alpha transitions are found to be approximately favored. The quadrupole moments Q_0^2, Q_{α}^2 of the even-even nuclei considered are calculated. These quantities are not known empirically, and, therefore, no comparison can be made at the present moment. For odd-A nuclei considered, none of the quantities β, γ, and K_f is known. It is therefore assumed that for $\gamma \leq 15°$ the alpha transitions for these nuclei will be approximately favored. It is then possible to explain the empirical reduced transition probabilities of the alpha groups of even parity in odd-A nuclei in terms of those in neighboring even-even nuclei. The comparison between theory and empirical data is quite satisfactory, supporting the assumptions involved. (auth)

31547 THE THREE-BODY PROBLEM IN NUCLEAR MATTER. Ramamurti Rajaraman. Thesis, New York, Cornell Univ., 1963. 91p.

An attempt is made to bring out the importance and evaluate the contribution of three-nucleon effects on the binding energy of nuclear matter. The Reference Spectrum Method is extended to cover all third-order diagrams. It is also shown that there are pure three-nucleon terms present in higher orders of perturbation and that they are large enough to be taken into account. An attempt is made to sum all these terms in a closed form and evaluate the three-nucleon correlation function. A Γ matrix is defined corresponding to the two-body reaction matrix. With its

help, the contribution of all three nucleon terms to the binding energy is evaluated approximately, and found to be about 10 Mev per particle. (auth)

31548 A SURVEY OF DEUTERON INDUCED ACTIVATION CROSS SECTIONS. Norton Baron. Thesis, Pittsburgh, Univ. of Pittsburgh, 1962. 64p.

A survey experiment was performed to measure the activation cross sections of various nuclear reactions induced by 20-Mev incident deuterons. Most of the activation cross sections measured were for (d,p), (d,t), (d,2p) and ($d,p\alpha$) reactions; in addition several cross sections are reported for (d,dγ), (d,2n), (d,α), (d,nα), and (d,He^3) reactions. After bombardment, radiochemical separations were performed on the activated targets, and the cross sections were subsequently determined by comparison beta counting. The (d,p) cross sections show a gradual increase from 78 mb for K^{41} to 120 mb for Pb^{208}. The (d,t) cross sections increase approximately linearly with neutron number from 6 mb for Ni^{58} to 49 mb for Au^{197}. Cross section calculations for the reactions $Ni^{58}(d,p)Ni^{59}$ and $Ni^{58}(d,t)Ni^{57}$, using the distorted wave theory of direct nuclear reactions, show good agreement with experimental values. It is concluded that (d,p) and (d,t) activation cross sections result, almost entirely, from a direct reaction process. The (d,2p) activation cross section for S^{32} is 139 mb and decreases rapidly to 0.014 mb for I^{127}. Statistical theory calculations for these reactions predict a level density parameter of about 4 Mev^{-1} for the heavier targets. However, the anomalous calculation results for the light weight targets such as S^{32}, Fe^{56}, and Co^{59} lead one to conclude that the (d,2p) reactions on light targets proceed by another mechanism. The ($d,p\alpha_0$) cross section is 72 mb for Cl^{35} and decreases rapidly to about 0.1 mb in the Zn region. These cross sections seem to hover between 0.2 mb and 0.05 mb from the Zn region out to the La region. Statistical calculations predict an evaporation path of first a proton and then an alpha for all cases studied except for the reaction on the lightest element, Cl^{35}, which is predicted to proceed primarily by the alternate evaporation path of first an alpha and then a proton. The level density parameters for the (d,pα) reactions increase as a function of atomic mass number in the Co–Br region. For heavier elements, the level density parameters decrease leading one to conclude that noncompound reaction mechanisms become increasingly important for heavier elements. All of the statistical calculations were performed on a 7070 IBM digital computer using a Fortran program written specifically for the calculation of statistical cross sections. (auth)

31549 THE ELECTRIC-DIPOLE GAMMA-RAY STRENGTH FUNCTION FOR HEAVY EVEN-EVEN NUCLEI. Raymon Thomson Carpenter. Thesis, Evanston, Ill., Northwestern Univ., 1962. 132p.

Gamma-ray spectra following neutron capture have been observed in a large number of neutron resonances in twelve even-even compound nuclei between Nd^{144} and Hg^{202}. Absolute values of the transition probabilities of the highest energy E1 gamma-ray transitions have been obtained for most resonances observed and averaged over all resonances considered in a given nuclide. The resonance-average values so obtained yield transition probabilities that are characteristic of the particular transitions considered with relatively good precision. This is in contrast to the values obtained from similar studies of thermal-neutron-capture gamma-ray spectra, which are beset with inherent and rather severe uncertainties. The dependence of the experimental values on the energy of the radiated gamma ray and the mass of the radiating nucleus is consistent with both the semiclassical prediction $A^{\frac{5}{3}} E_\gamma^3$ and the recent prediction of the giant-dipole-resonance approximation, $A^{\frac{5}{3}} E_\gamma^5$. Further, if either of these mass-energy factors is removed, the resulting reduced widths are observed to be closely proportional to the spacing of neutron resonances, as predicted by both theories. It thus becomes significant to define an E1 gamma-ray strength function as the resonance-average value of the partial width divided by the average spacing between neutron resonances and the appropriate energy factor and to study its dependence on the atomic mass of the radiating nucleus. The E1 gamma-ray strength functions have been constructed according to both proposed energy dependences and are found to follow the predicted mass dependence, although there are suggestions of peaks near the closed neutron shells. The absolute value of the strength function constructed according to the giant-dipole-resonance approximation is in reasonable agreement with the theoretical prediction, but there is violent disagreement in the other case. The implications of this and other aspects of the results are discussed. Since the techniques used to analyze the data are for the most part new, they are dealt with in considerable detail. The pertinent theory and the techniques used to obtain the data are also discussed. (auth)

Particle Accelerators

Refer also to abstracts 30044, 30122, 30123, 30124, 30125, 30160, 30161, and 30854.

31550 (AERE-R-4093) AN INSTALLED FAST NEUTRON AND GAMMA HEALTH INSTRUMENTATION AND SHUTDOWN CONTROL SYSTEM FOR NIMROD. J. E. Maddock (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1963. 41p.

The health instrumentation and shutdown control system to be used as part of the 7-Bev proton synchrotron machine (Nimrod) are described. Twin ion chamber detectors are used to measure dose and/or dose-rate from mixed neutron and gamma radiations and an indication of dose and dose-rate can be provided near the detectors and in a central control room. The shutdown control channel comprises equipment for the measurement of radiation dose per pulse with provision for initiating immediate shutdown of the machine should the dose per pulse exceed a pre-set value. (auth)

31551 (CERN-63-12) UN FAISCEAU D'USAGE GENERAL A DEUX ETAGES DE SEPARATION ELECTROSTATIQUE AU PS. (A Beam for General Use with Two Stages of Electrostatic Separation at the PS). J. Goldberg and J. M. Perreau (European Organization for Nuclear Research, Geneva). Apr. 9, 1963. 21p.

A m_2 beam was constructed initially to produce K^+ separated by 1.5 Bev/c. It was also used to produce K^- separated at 3.5 Bev/c and $\bar{p}$ separated at 5 Bev/c. The beam conserves the achromatic optics of the m_1 beam. In the m_2 beam the angle of emission was 8.5° to the target. Two separators of the NPA type of 10 m each, separated into two stages, were provided. The flexibility necessary was obtained by using a triplet in the first stage, the supplementary degree of freedom allowing the magnification or the acceptance. The optics for the K^- and high intensity $\bar{p}$ are described. Methods used for improvement of the optics, including measurement of the vertical image dimension, position of horizontal images, inverse field separators, and sextupole, are discussed. (J.S.R.)

31552 (LNF-63/34) ELEMENTI DI PROGETTO DI UN ANELLO DI ACCUMULAZIONE PER ELETTRONI E POSITRONI DA 750 Mev. (Design Elements of a Positron and Electron Storage Ring at 750 Mev). Note No. 199. F. Amman, R. Andreani, M. Bassetti, et al. (Italy. Comitato Nazionale per l'Energie Nucleare. Laboratori Nazionali, Frascati). May 7, 1963. 82p.

The design of a storage ring for positrons and electrons at 750 Mev is described in detail. The elements discussed are the magnetic structure, magnets and their power supply, magnetic measurement, injector, injection optics, deflector, vacuum system, radiofrequency, and luminosity at beam crossing. (J.S.R.)

31553 (LNF-63/38) DISPOSITIVO PER LA MISURA DELL'ENERGIA DEGLI ELETTRONI CIRCOLANTI IN UN SINCROTRONE. (Apparatus for the Measurement of the Energy of Electrons Circulating in a Synchrotron). Note No. 201. R. Del Fabbro, G. V. Di Giorgio, F. Losciale, S. Serbassi, G. Ubaldini, M. L. Vincelli, and R. Visentin (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). May 27, 1963. 8p.

A device for the measurement of the energy of electrons circulating in a synchrotron at a given moment was studied and constructed. The principle of this device is indicated, and a block diagram is given. The chronological sequence of signals after input is described. The electronic circuits are given. (J.S.R.)

31554 (NIRL/R/28) DESIGN STUDY FOR THE TRIM-COIL SYSTEM TO BE USED ON THE VARIABLE ENERGY CYCLOTRON AT HARWELL. A. R. Mayhook (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). Mar. 1963. 15p. (VEC-4)

By means of a Fortran computer program corrected (isochronous) magnetic fields for the Variable Energy Cyclotron were obtained. Three different particles covering three different field levels were considered, including the cases thought to be most difficult. The effects of changing the main parameters on which the solution depends are discussed. The main conclusions are that 12 trim-coils will be required; that the spacing of the coils has little effect on the solutions; and that the proposed upper limit of 1000 amps on the trim-coil currents is reasonable, although a higher value would be an advantage. The possibility of imposing a lower limit on the magnitude of the trim-coil currents is also discussed. Some improvements that should be made in the method of obtaining the corrected fields are noted. (auth)

31555 (NIRL/R/33) THE NIMROD MAGNET: SATURABLE-FIN POLEPIECES. J. J. Wilkins and D. A. Gray (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). Apr. 1963. 38p.

The general characteristics of synchrotron polepieces with saturable fins, i.e., saturable edges, are discussed. Measurements on a magnet model are presented to illustrate the major factors involved. It is shown that the peak magnetic flux in the magnet yoke can be reduced significantly for a given, useful low-field aperture. Correction of the field distribution in the magnet gap at high field levels, by 'crenellation' techniques, or by compensating slots, is discussed and illustrated. (auth)

31556 (NIRL/R/36) A DESCRIPTION OF SOME CORRECTED (ISOCHRONOUS) FIELDS USED FOR DESIGN STUDIES ON THE HARWELL VARIABLE ENERGY CYCLOTRON. D. A. Harragan and A. R. Mayhook (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). Mar. 1963. 21p. (VEC-1)

Corrected fields are produced for three different particles: 50-Mev protons, 140-Mev nitrogen + 5 ions, and 95-Mev neon + 5 ions. The first two are used for preliminary extraction studies, and the third is used to test the effects on phase slip of accelerating particles with the third harmonic of the r-f magnetic field. The magnetic fields on which the calculations are based and the calculations leading to the corrected fields are described. Parameters of the equilibrium orbits of the particles in each of the corrected fields produced are tabulated as functions of energy, and the variation of the phase of the particles with respect to the r f as a function of radius is shown graphically. (auth)

31557 (NIRL/R/37) AN ACCOUNT OF PRELIMINARY COMPUTER STUDIES OF EXTRACTION IN A VARIABLE ENERGY CYCLOTRON. D. A. Harragan, A. R. Mayhook, and W. Walkinshaw (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton Berks, England). Mar. 1963. 18p. (VEC/5)

Computer studies made on the fields from the ⅓th scale model of the variable-energy cyclotron to be built at Harwell are discussed. One of the decisions that had to be made before engineering could be initiated was the orientation and sense of the magnetic field spiral ridges. This depended partly on ease of extraction. Details of the work done in running different ions through electrostatic channels are given. (auth)

31558 (ORNL-3431) A STRONG-FOCUSING CYCLOTRON WITH SEPARATED ORBITS. F. M. Russell (Oak Ridge National Lab., Tenn.). Jan. 1963. Contract W-7405-eng-26. 77p.

The concept and basic theory of a new fixed-frequency, fixed-field, high-energy accelerator embodying the principle of strong-focusing and capable of accelerating protons to energies in the Bev region is described. The magnetic field is designed with the turns of the 'equilibrium orbit' separated axially as well as radially, as in a spiral-helix, so as to avoid the resonances associated with alternating-gradient systems. The focusing properties can be changed discontinuously at chosen points along the orbit to avoid the error resonances. Longitudinal stability is present, as the system is phase stable. Ions spiral repeatedly through several accelerating cavities operated in the TE mode and spaced regularly around the machine. Each cavity extends both radially and axially to intercept all turns only once. Injection and extraction are straight-forward and the final energy can be varied by extracting at chosen points along the orbit path. A preliminary design for a 1-Bev machine is described, and a comparison is made between the proposed machine and some contemporary types of accelerators. The cost estimate compares favorably with that of other machines with which it is compared. (auth)

31559 (TID-19016) THE UNIVERSITY OF MICHIGAN 83-INCH CYCLOTRON. Progress Report No. 12, April 1, 1963–June 30, 1963. W. C. Parkinson and R. S. Tickle (Michigan. Univ., Ann Arbor. Coll. of Literature, Science, and the Arts). July 1963. Contract AT(11-1)-921. 5p. (ORA-03763-12P)

Tests without the gradient coils energized confirmed previously noted defocusing at 34 in. The beam intensity at full radius (36.5 in.) was a factor of 30 to 40 less than at 33 in. With the proper gradient coil current values no beam loss between 33 in. and full radius was observed. Extrac-

tion of 10 μamp of 12-Mev proton with 40% efficiency was achieved. Protons at 8 to 24 Mev and deuterons at 15 to 40 Mev were accelerated to the extraction radius, and high currents were readily obtained at the extraction radius. Preliminary shielding tests showed no problems with 200 μamp of 40-Mev deuterons on copper. The dee voltage regulator was adjusted, and satisfactory operation of the r-f system over the design range of frequencies, 6.5 to 15 Mc, was obtained. The three beam analyzer magnets were installed and connected. Tests on the two beam-preparation magnets revealed difficulties with polonium creeping and flaking. (D.C.W.)

31560 (UCRL-10396) BEVATRON ELECTRICAL SYSTEM CONTROLS, INTERLOCKS, AND WIRING RECORDS. Clarence A. Harris (California. Univ., Berkeley. Lawrence Radiation Lab.). July 31, 1963. Contract W-7405-eng-48. 120p.

The electrical control system of the Bevatron is described. The system of prints, the complex of control and coax cables, and some of the general electrical control problems of nuclear accelerators are discussed. The details of the electronic control chassis and components such as the RF tracking system are not covered. (auth)

31561 (UCRL-10613) BEVATRON OPERATION AND DEVELOPMENT. XXXIV, MAY AND JUNE 1962. Kenneth C. Crebbin, William A. Wenzel, Harold W. Vogel, Henry D. Lancaster, and Rudin M. Johnson (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 4, 1963. Contract W-7405-eng-48. 19p.

External beam was achieved with the new two-magnet extraction system. It was estimated that about one-half of the circulating beam was extracted. Flat-top operation of the magnet current was achieved by delaying the changeover time between the two separate power-supply units. New equipment for magnet ripple reduction was successfully tried at the same time, which permitted this type of flat-top operation to be used. Immediately prior to the June shutdown, flat-top operation accounted for a large percentage of the total operation. The new linear-accelerator injector was successfully operated and achieved 15 mamp of protons at 19.2 Mev. Bevatron operation and the experimental research program are summarized. (auth)

31562 DISCHARGE DEVICE OF LINEAR ELECTRON ACCELERATOR OF 90 Mev ENERGY. I. A. Grishaev, V. V. Kondratenko, V. V. Petrenko, A. T. Popov, V. A. Shuko (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 2, 26-8(Mar.-Apr. 1963). (In Russian)

Construction problems, experimental research, and adjustment of the achromatic parallel transmission system of an electron beam linear accelerator that conducts about 50% of the accelerator current to the target were investigated. The best monochromatic beam energy ratio was $\Delta E/E = \pm 0.003$; the widest possible energy spectra established for this system was $\Delta E/E = \pm 0.05$, with an efficiency of 0.5. (tr-auth)

31563 CLOSED VACUUM SYSTEM FOR BETATRON WITH TITANIUM PUMP. V. P. Ponomarev (Scientific Research Inst. of Nuclear Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 2, 121-4(Mar.-Apr. 1963). (In Russian)

Designs for two closed vacuum systems for a betatron in the energy range of 25 Mev with a titanium pump that provides a vacuum of $(1-3) \times 10^{-6}$ mm Hg in the chamber are described. The betatron vacuum system with the titanium pump was compared with an oil-vapor diffusion pump and unsoldered chambers. Characteristics of semi-soldered chambers were included. (tr-auth)

31564 MAGNET EXCITATION FOR A PROTON ACCELERATOR. G. O. Calabrese (Argonne National Lab., Ill.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-991, 21p, $1.00. (CONF-1-6)

From Summer Meeting, Toronto, June 1963.

The power required by the magnet excitation and the requirements of the particle accelerating system of a particle accelerator are affected by the time variation of the magnet voltage e_1 with time. The design of a particle accelerator necessitates the calculations of i, e_1i, (di/dt), B, (dB/dt), etc. under different assumptions for the shape of e_1 as a function of time. Two methods that are applicable respectively to longhand and computer calculations and that, in addition to the time variation of e_1, permit taking into consideration the variation of the incremental inductance L_i with saturation are outlined. Any desired degree of accuracy can be attained. (auth)

31565 RECENT WORK ON THE PRINCETON-PENNSYLVANIA ACCELERATOR R. F. SYSTEM. C. L. Kang and H. S. Reichard (Princeton-Pennsylvania Accelerator, Princeton, N. J.). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint 63-1072, 7p, $1.00. (CONF-1-9)

From Summer Meeting, Toronto, June 1963.

Operation of the master oscillator, the phase control scheme, beam monitoring system, and the ferrite biasing systems is briefly discussed. Modifications to the r-f system are described. Acceleration to 3 Bev was first attained in April. The machine is performing satisfactorily with no excessive loss of particles at the drift tube/cavity cross over. The feasibility of obtaining frequency ranges of more than 10 : 1 by combining the drift tube and cavity systems was verified. (D.C.W.)

Plasma Physics and Thermonuclear Processes

Refer also to abstracts 30830 and 30831.

31566 (AFCRL-63-642) PROPAGATION OF WAVES IN INHOMOGENEOUS MAGNETO-ACTIVE PLASMA COLUMNS. Technical Note No. 3. Pietro de Santis (Selenia S. p. A., Rome). Jan. 29, 1963. Contract AF61 (052)-145. 24p.

The propagation of a quasi-static E mode in a plasma column with a parabolic electron density distribution in the cross section is investigated in the case of a plane geometry. The Ritz variational method is used when a first order approximation for the field distribution is assumed. Uniform case equations are verified, and the dispersion curves for a completely filled waveguide and for a slab of plasma in free space are plotted. (auth)

31567 (CONF-24-11) BEHAVIOR OF SPARK GAP SWITCH IN HIGH-Q RINGING CIRCUIT. F. H. Tenney (Princeton Univ., N. J.). [nd]. Contract AT(30-1)-1238. 9p.

From Symposium on Engineering Aspects of Magnetohydrodynamics, Berkeley, Calif., April 1963.

The spark gap switch to be used in a ringing circuit that will heat plasma in the model C Stellarator was studied. A model for the spark gap behavior, and relations for the Q of the circuit and of the gap, were obtained. Tests were made with circuits of high-Q capacitors, the spark gap switch, and an inductance to produce a ringing frequency of

about 100 kc. The spark gap triggered successfully for a few hundred thousand shots. Monitoring the capacitor voltage showed the presence of both long and short rings. Evidence for a double moding of the spark gas discharge was obtained. Such moding gives an effective Q of 286 for the gap, nearly prohibitive for use in the planned ringing circuit. (D.C.W.)

31568 (CONF-24-12) THE DESIGN OF A CAPACITOR AND SWITCH ASSEMBLY FOR LOW INDUCTANCE. R. S. Dike and E. L. Kemp (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 11p.

From Symposium on Engineering Aspects of Magnetohydrodynamics, Berkeley, Calif., April 1963.

Certain plasma physics experiments require ultra-low inductance capacitor banks to provide power for fast-rising magnetic fields. The design of a switch header integrated with a capacitor that minimizes the inductance is described. The assembly of the 5-μf, 25-kv capacitor and the mating size A ignitron has an inductance of 0.04 μH, which is a factor of 4 less than a previous design. This system can deliver 155 ka in 0.75 μsec. Applications and operating experience are presented. (auth)

31569 (CONF-38-2) THE HOSE INSTABILITY FOR RELATIVISTIC PARTICLE BEAMS IN A PLASMA BACKGROUND. R. C. Mjolsness (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna. and Los Alamos Scientific Lab., N. Mex.); Jacob Enoch, and C. L. Longmire (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 25p.

From 4th Annual Meeting, American Physical Society, Atlantic City, N. J., Nov. 28-Dec. 1, 1962.

A macroscopic analysis is given of the low frequency, long wavelength instabilities of the relativistic beam-plasma configuration. A two mass approximation is used for the particle dynamics. Plasma effects are accounted for by means of a tensor conductivity whose non-diagonal elements are due to the self-magnetic field of the beam. The analysis is directed toward establishing the effect of the non-diagonal terms on growth rates. Three approximate methods of analysis are discussed. The conclusion is that the nondiagonal terms, even when large, contribute minor modifications to the dispersion law. (auth)

31570 (GA-4202) ON ANGULAR MOMENTUM OF A THETA PINCH PLASMA. T. H. Jensen and H. G. Voorhies (General Atomic Div. General Dynamics Corp., San Diego, Calif.). June 4, 1963. 23p.

A model for the origin of the angular momentum in a theta pinch plasma is suggested. This model predicts that the angular momentum is proportional to the trapped magnetic flux. Experimentally it is observed directly that the plasma has an angular momentum. The sign of the angular momentum, generally, is the one needed to explain fission instability. The angular momentum is measured with an unknown efficiency with a torsion pendulum, and the trapped flux is also measured with some uncertainty. The directly measured angular momentum is about 1% of that obtained from a trapped flux measurement. Transfer of angular momentum from plasma to pendulum is apparently inefficient. (D.C.W.)

31571 (GA-4285) PLASMA FLOW INTO A PERPENDICULAR MAGNETIC FIELD. F. Robert Scott, Nicholas A. Krall, and Ralph G. Tuckfield, Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 21, 1963. 17p.

The interaction of a highly directed helium plasma with a carefully isolated perpendicular magnetic field was studied experimentally in the region where $\rho v^2 \approx B^2/8\pi$. Initially the plasma has a mean directed energy of 240 ev with a maximum ion density of 2×10^{14} charges/cm^3. As the plasma enters the field region through a circular aperture, it appears extended laterally to the full entrance diameter along the field lines but appears constricted in the other dimension of the aperture plane. In time, the plasma penetrates far into the perpendicular field in a wedge shape and expands along field lines. Time-resolved optical photography, magnetic probe data, and time-integrated calorimeter measurements indicate a flute-type growth of the plasma penetration which has a lateral extent compatible with the smallest wavelength not stabilized by finite Larmor radius effects. Measurements of the lateral extent of the diamagnetic signals and calorimeter response as a function of field strength show that the "flute" wavelength varies approximately as the Larmor radius. Flow patterns obtained from magnetic probe data as well as time-resolved photographs show the mean "flute" penetration velocity to be approximately 3 cm/μsec and the mean expansion velocity along field lines to be 2.5 cm/μsec. (auth)

31572 (IPPJ-7) STABILITY OF PLASMA. [PART] I. Masatomo Sato (Nagoya, Japan. Univ. Inst. of Plasma Physics). Mar. 1963. 99p.

Several types of macroscopic instabilities in a plasma in a magnetic field are discussed with emphasis on the physical interpretations of instability mechanisms and of methods of stabilization. Main interest is in the stability conditions as derived by the linearized theories, but a brief discussion is also given to some turbulent states after the development of instabilities. Efforts are made to refer to the experimental information as far as possible. 86 references. (auth)

31573 (IPPJ-9) RADIATION BY PLASMA WAVES IN A HOMOGENEOUS PLASMA. Yoshinosuke Terashima and Nobuo Yajima (Nagoya, Japan. Univ. Inst. of Plasma Physics). Mar. 1963. 25p.

Conversion of the energy of a plasma wave into electromagnetic radiation as a result of plasma wave scattering on density fluctuations of a statistical nature in a homogeneous plasma is treated. Boltzmann-Vlasov equations and Maxwell equations are used, and plasma wave scattering within a localized region of the main plasma is handled as a stationary problem. Equations for the scattered fields having both the longitudinal and the transverse mode are given using the Born approximation. A far-distance solution of the fields is also obtained, using a Fourier transform over space and time; and radiation intensities are expressed in terms of mass and charge fluctuations. The results are compared with works on non-uniform models. (D.C.W.)

31574 (LAMS-2911) COMPARISON OF COMPUTED AND MEASURED BEHAVIOR OF FAST THETA PINCHES. F. L. Ribe, R. M. Gilmer, H. C. Hoyt, G. Hain, and K. Hain (Los Alamos Scientific Lab., N. Mex.). May 22, 1963. Contract W-7405-eng-36. 23p.

Comparison with experiment shows that a two-fluid hydromagnetic computation, which includes collisional transport effects, predicts much of the behavior of the Scylla I θ-pinch plasma with remarkable accuracy. The computed density and electron temperature at maximum compression agree well with the experimental values, as do the initial dynamics of the implosion. In the case of trapped magnetic field ≥ 0 there is no discrepancy between

computed results and the plasma quantities observed thus far. However, in the case of $-B_0$ the rapid interdiffusion of the trapped and compressing fields that is observed experimentally is absent from the calculation. So also are the almost complete diamagnetism and high ion energy observed experimentally. The computation shows little difference between the cases of positive and negative B_0. In particular the electron temperatures T_e in the two cases are nearly the same. (auth)

31575 (MATT-194) INTERPRETATION OF OBSERVED IMPURITY RADIATION IN A DISCHARGE OF THE C-STELLARATOR. Einar Hinnov (Princeton Univ., N. J. Plasma Physics Lab.). May 1963. Contract AT(30-1)-1238. 34p.

Measurements of absolute intensities of the resonance multiplets of oxygen ions in a typical discharge of the C-Stellarator are employed to deduce the ion concentrations as a function of time. The analysis of the data is based on an idealized model in which electron temperature and density are uniform both radially and axially. Electron temperatures are found from relative intensities of some of these multiplets, and compared with temperature computed from the electrical conductivity. Mean particle confinement times are deduced from the time behavior of the concentrations of highly ionized oxygen. From these confinement times, and the observed electron density changes, the particle influx rates are obtained. The total power loss by radiation is evaluated for the uniform model. The radiation by oxygen ions, which is explicitly nearly independent of temperature, and the ionization and heating of hydrogen influx, which is nearly proportional to temperature, are found to be the dominating mechanisms of power loss. (auth)

31576 (NP-12976) RESONANCE OSCILLATIONS IN A HOT NON-UNIFORM PLASMA. Technical Report No. 20. Jerald V. Parker (California Inst. of Tech., Pasadena). May 1963. Contract Nonr-220(13). 13p.

The hydrodynamic equations of a hot nonuniform plasma were solved numerically in slab geometry to obtain the resonant frequencies and associated wave functions. The splitting of the various resonances is shown to depend on the parameter: (slab thickness ÷ Debye length). (auth)

31577 (ORNL-3325) ENGINEERING FEATURES OF DCX-2. P. R. Bell, J. S. Culver, S. M. DeCamp, J. C. Ezell, G. G. Kelley, N. H. Lazar, and R. J. Mackin, Jr. (Oak Ridge National Lab., Tenn.). July 26, 1963. Contract W-7405-eng-26. 30p.

The DCX-2 is a large, complex experimental apparatus. Its aim is the generation of a hot, dense plasma by the injection and dissociation of 600-kev hydrogen molecular ions in a magnetic-mirror field. For facilitating this process, the molecular ions are given a long path in the machine, and the ion-pumping action of the plasma is used to maintain the vacuum. The major component systems of the apparatus are the ion source and accelerator, high-voltage power supply, magnet system, beam-injection duct, vacuum system, and dissociating arc. The design, construction, and performance of each component system, the constructional features not peculiar to any one component, and the instruments and techniques available for plasma study are described. (auth)

31578 (SSD-TDR-63-120) A SURVEY OF SOME PLASMA ACCELERATION DEVICES FOR SPACE PROPULSION APPLICATIONS. D. M. Dix (Aerospace Corp., El Segundo, Calif.). May 17, 1963. Contract AF04(695)-169. 51p. (AD-408565).

The current status of pulsed plasma accelerators and steady-state $\underline{j} \times \underline{B}$ accelerators is summarized. Emphasis is placed upon three areas of the current state of knowledge: the basic interaction by which acceleration is accomplished; the loss mechanisms which exist in a given type device; and experimental results relevant to either of these two factors, as well as results of performance measurements. (auth)

31579 (AEC-tr-5589) PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH, CONFERENCE PROCEEDINGS, SALZBURG, 4-9 SEPTEMBER, 1961, [Soviet Papers]. Translated from Preprints of Russian Papers Presented at the Conference. 1046p.

The two volumes contain 56 papers on plasma behavior and properties in various traps, plasma interactions with fields and radiations, particle motions in plasmas, plasma heating, radiations from plasmas, plasma stability, plasma confinement, and related topics. (D.C.W.)

31580 (AERE-Trans-934) DIFFUSION OF FULLY IONISED PLASMA ACROSS A MAGNETIC FIELD. I. CLASSICAL THEORY. S. Yoshikawa. Translated by S. G. Brickley (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Kakuyugo-Kenkyu, 7: 123-33(1961). 13p.

The model of Bernard and Dolique is used for a classical discussion of the phenomenon. The Chapman-Enskog expansion in the first and second expansion is applied to the Boltzmann equations to obtain the continuity and kinetic equations for the plasma. The density is noted not to depend on Z (the cylindrical axial direction, magnetic field direction). Still in the first order approximation, consideration of an infinite cylinder shows that the diffusion is proportional to $1/B^2$ and that the diffusion coefficient is $(\nu_c/\omega_e)^2$ times that for no magnetic field. ω_e is the electron cyclotron frequency; ν_c is the electron frequency. Consideration of a finite cylinder leads to the conclusion that when y has a high value, separation is brought about by the forming of a clear plasma-vacuum boundary. In the second approximation, diffusion is proportional to $1/B^4$. With ambi-polar diffusion, the ion drift velocity in the θ direction is 0. (D.C.W.)

31581 (NP-tr-1025) AN ASYMPTOTIC METHOD IN THE THEORY OF STABILITY. A. A. Galeev. Translated by D. L. Allan (U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, Eng.) from preprint issued by Novosibirskii Gosudarstvennyi Universitet, U.S.S.R., 1962. 16p.

Solutions of the integro-differential equations met in obtaining eigen-frequencies in the linear theory of the stability of ionized gases are derived by asymptotic methods. The form of the equations for specific cases are considered. (D.C.W.)

31582 DEBYE-HUCKEL PLASMA CORRECTIONS. Malcolm McChesney (Univ. of Liverpool). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 1666-8(July 1963).

The physical model recently used by McGee and Heller to compute the thermodynamic properties of gaseous plasma is questioned. For the medium-density plasma, the Debye-Huckel theory of point charges is adequate and provides both a cutoff for the electronic partition function and a lowering of the ionization potential. The difficulties of the high-pressure plasma model are mentioned briefly. (auth)

31583 HIGH OPTICAL GAIN AT 3.5 μ IN PURE XENON. William B. Bridges (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Letters, 3: 45-7(Aug. 1, 1963).

Optical gains of 50 to 59 db/m at 3.508 μ are reported for pure xenon plasma. Gain measurements with the amplifier operating as a hot cathode d-c discharge tube are shown. The apparent decrease in gain is partially explained by the shorter discharge length occurring with d-c excitation. Addition of He to the discharge initially increased the gain slightly but a visible separation of the two gases by cataphoresis occurs in a few seconds at the higher discharge currents required, and the gain is drastically reduced. The variation of gain per unit length as a function of He pressure is also presented. (C.E.S.)

31584 ON THE THEORY OF MICROWAVE RESONANCE IN A HOT PLASMA COLUMN. J. Helmer (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 23: 515-26(1963). (In English)

The electron resonances of a homogeneous, hot plasma column are derived. The temperature of the gas is accounted for by the inclusion of an isotropic pressure term in the equation of motion. Both static and wave type resonances are found. These correspond to identical resonances in the cold plasma, with the exception that the degeneracy of the wave modes in the cold plasma is removed by the doppler effects of electron motion, creating a spectrum of resonances where formerly there was a single resonance. The calculated splitting of the wave resonances is however a factor of 10 less than the experimentally observed splitting. Moreover the wave modes are not by themselves observable, because D = 0. They could be made observable by coupling to the static modes in the inhomogeneous sheath region, however an analysis of the sheath equation shows that this coupling may be quite weak. Therefore it is unlikely that the theory of the homogeneous plasma can explain the experimental results. A theoretical result is that the d-c sheath field acts to keep the effective electron plasma frequency high throughout the sheath. In this way the $\epsilon = 0$ singularity in the static mode is avoided. The adiabatic solutions for wave motion in a one dimensional, inhomogeneous plasma are given, and it is indicated how the general problem may be approached. (auth)

31585 MOMENTUM BALANCE OF A ROTATING PLASMA. J. Bergstroem, S. Holmberg, and B. Lehnert (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 23: 543-69(1963). (In English)

An experimental study was made of the momentum balance of a rotating plasma that is confined in the magnetic field produced by a current loop. The time constant of the rotation was determined both from investigations of a quasistationary state and of a free-wheeling mode where the plasma is disconnected from its energy source. The time constant is found to increase strongly with the applied field as well as with the transverse dimensions of the confinement region. Investigations of the free-wheeling mode also seem to indicate that the containment time of individual particles is much longer than the time constant of the rotation. Further, probe measurements show that the plasma current is developed into radial strips during the starting period of the discharge. These strips disappear during later stages. The plasma seems to behave in agreement with classical theory during its decay period and in a free-wheeling mode. The momentum balance can be explained by viscous friction between the plasma layers, and there is so far no indication that the balance should be limited by particle losses along the magnetic field or by instabilities. The obtained time constants at least show that the plasma is far less unstable than what is predicted by earlier theories on flute phenomena. (auth)

31586 REMARKS ON THE TRANSPORT PROPERTIES OF A FULLY IONIZED GAS WITH APPLICATION TO A RADIALLY CONSTRICTED GAS DISCHARGE. P. W. Seymour (Australian National Univ., Canberra). Australian J. Phys., 16: 216-27(June 1963).

The correction of Vaughan-Williams and Haas to Marshall's λ' set of thermal conductivities for a fully ionized hydrogen isotope in the presence of a magnetic field is extended to the λ and $\beta\theta$ sets, and the high-field limits for the components perpendicular to the magnetic field are included. The results of Kihara, Midzuno, and Kaneko for the rate of entropy production due to irreversible processes in an anisotropic plasma are then used to obtain the Onsager expressions for the reduced heat flow and the electric field respectively, when the magnetic field is zero. From these Onsager expressions Spitzer's expressions for the absolute heat flow and conduction current density are obtained, with attendant derivation of relations between the scalar transport coefficients referred to earlier by Spitzer, Kaneko, and Seymour. Comparison of results obtained by Kaneko, Marshall, and Landshoff for the 2nd approximation to the scalar electrical, thermal, and thermoelectric transport coefficients of an isotropic deuterium plasma shows close agreement. The corresponding results of Spitzer and Härm in infinite approximation are also included for purpose of comparison. Finally, the influence of Marshall's corrected thermal conductivities on the radial heat flow approximation in Seymour's earlier analyses of a radially constricted deuterium plasma between electrodes is considered, and it is shown that the original basic approximation of perfect thermal insulation at the free boundary surface of the plasma can still be made more plausible in the limit of a strong external guiding magnetic field, provided that this magnetic field corresponds to the more stringent inequality $\omega^2\tau^2 \gg 1400$ (ω the electron gyrofrequency, τ the electron collision time) for highly ionized deuterium, rather than the inequality $\omega\tau \gg 1$ that appeared in the earlier analyses. (auth)

31587 A STUDY OF THE PROPERTIES OF HIGH-VELOCITY PLASMOIDS. V. F. Demichev and V. D. Matyukin. Dokl. Akad. Nauk SSSR, 150: 279-82(May 11, 1963). (In Russian)

The initial voltage on a bank of condensers U_0 was varied from 3 to 15 kv; the lag time Δt from the moment of injection to the breakdown of the gas was varied from 150 to 250 μsec, and the quantity of gas M was varied from 0.1 to 1.2 cm^3 of gas at atmospheric pressure in order to determine the effect of the velocity and energy of the separated plasmoid. The velocity of the plasma bundle was determined from the time of flight along a tube 120 cm long and 10 cm in diameter recorded by two coils in a local magnetic field of 100 to 200 oersteds. The longitudinal dimensions of the plasmoid near the injector at a distance Δl_1 and at a distance 75 cm from the injector at a distance Δl_2 were estimated from the magnitude of the electric current $\Delta\phi$ due to the plasmoid cutting the magnetic field, and from the measured velocity. The average rate of transverse expansion $\nu_\perp$ is always less than the rate of longitudinal expansion $\nu_\parallel$. The plasmoid can split into two or more bundles, especially at a distance of 70 to 100 cm from the injector. The velocity of the front bundle (or fore plasmoid) exceeds the velocity of the second, main plasmoid, and its velocity depends more strongly on U_0. For example, on increasing H_0 from 7 to 10 kv, the velocity of the fore plasmoid v' increased from 1.8×10^7 to 4.5×10^7 cm/sec, whereas the velocity of the main plasmoid increased only

from 9×10^6 to 1.1×10^7 cm/sec. On increasing U_0 to 12 to 15 kv, the velocity of the fore plasmoid increased to 10^8 cm/sec. Calorimetric measurements showed that the plasmoid energy was ~100 joules at $U_0 = 5$ kv, and 2000 joules at $U_0 = 12$ kev. The energy of the fore and main plasmoids was determined by measuring the infrared radiation from a 6 μ platinum foil with a time resolution of 1 μsec. It was found that the energy of the fore plasmoid far exceeds the energy of the main plasmoid. The average mass and particle density in both plasmoids were determined. The reflection of energy from a metallic surface must be taken into account, when the particle density is about 10^{15} cm^{-3}. (TTT)

31588 AN ANALOGUE COMPUTER STUDY OF THE TOWNSEND GAS DISCHARGE. R. J. Churchill and D. F. Gallaher (Univ. of British Columbia, Vancouver, Can.). J. Electron. Control (1), 14: 599-607(June 1963). (In English)

An analog computer is described which simulates the modified Townsend gas discharge equation including primary and secondary ionization and attachment. Prebreakdown ionization current characteristics for various gases were extended to relatively large values of parameter E/P. Computer solutions of the modified Townsend equation are in good agreement with experimental results. (auth)

31589 DISPERSION RELATION FOR THE CASE OF A FINITE COLD ELECTRON BEAM PENETRATING A PLASMA. S. V. Yadavalli (Stanford Research Inst., Menlo Park, Calif.). J. Electron. Control (1), 14: 633-5(June 1963). (In English)

The dispersion relation describing the excitation of longitudinal plasma oscillations is assumed to be $\omega_p^2/\omega^2 + \omega_b^2 f^2/(\omega - kv)^2 = 1$ for the case of a finite electron beam of radius b, where f^2 accounts for the finiteness of the beam. The factor f^2 accounts for the finiteness of the beam. The factor f^2 is evaluated for the case where $kb \ll 1$ (k = wave number of a Fourier component of the perturbation). The following equation is derived: $f^2 \cong (k^2 b^2/2\,\epsilon_c)[-\gamma + (1 - 2 \log kb/2)/kb]$. It is noted that the system of an electron beam penetrating a plasma is always unstable. (D.L.C.)

31590 EXPLORER 10 PLASMA MEASUREMENTS. A. Bonetti, H. S. Bridge, A. J. Lazarus, B. Rossi, and F. Scherb (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 68: 4017-63(July 1, 1963).

Plasma measurements were made with a detector aboard the Explorer 10 satellite, launched on a highly elongated elliptical trajectory with the line of apsides about 33° to the antisolar direction. Magnetic field measurements were also carried out on Explorer 10 by the Goddard Space Flight Center of NASA. A plasma moving with a velocity of about 300 km sec^{-1} was first observed when the satellite reached a distance of about 22 earth radii. During the rest of the observations (which terminated about 40 hours later, at a distance of 42 earth radii), periods in which substantial plasma fluxes were recorded alternated with shorter periods in which the plasma flux was below or just above the detection limit. There was a striking correlation between the plasma flux and the magnetic field: in the absence of plasma the magnetic field direction was nearly radial from the earth, whereas in the presence of plasma, the field was irregular and generally formed large angles with the earth-satellite direction. The plasma probe did not provide accurate information on the direction of the plasma flow, but placed the direction within a "window" of about 20° by 80°. This window includes the direction pointing radially away from the sun. The flux densities of the positive ions (presumably protons) corresponding to the observed currents were of the order of a few times 10^8 cm^{-2} sec^{-1}. They fluctuated over a range of about a factor of 2 during the periods when plasma was observed. (auth)

31591 STABLE PLASMA IN A DISCHARGE OF THE INVERSE PINCH TYPE. P. H. Rebut and A. Torossian (CEA, Fountenay-aux-Roses, France). J. Nucl. Energy, Pt. C, 5: 133-44(May-June 1963). (In French)

In accordance with theory, it has been possible to obtain a stable plasma in a discharge of the inverse pinch type. Stability is indicated by very good reproducibility of the discharge, and an absence of fluctuations in the magnetic and electric fields. Unfortunately the presence of electrodes limits the lifetime of the particles. (auth)

31592 THE DISTURBING MAGNETIC FIELDS CAUSED BY GAPS IN TOROIDAL METAL DISCHARGE TUBES. N. L. Allen, D. Balfour, L. A. Green, R. F. Hemmings, and A. A. Ware. J. Nucl. Energy, Pt. C, 5: 151-9(May-June 1963). (In English)

When a toroidal current is induced within a hollow metal torus eddy currents generate radial magnetic fields (B_r) at the gaps in the torus. A simple theory is put forward to relate these fields to the distribution of B_θ on the inner and outer surfaces of the torus. Measurements of B_r and B_θ made on the Levitron torus and Sceptre IV show agreement in sign and order of magnitude with the simple theory. The radial fields are often of the same order of magnitude as B_θ. In the case of the toroidal pinch discharge the radial fields can be eliminated only by using gaps with small overlap (or shallow flanges) and suitably positioning the primary windings on the outside of the torus. (auth)

31593 ELIMINATION OF FIELD ERRORS AND RAPID FIELD PROGRAMMING FOR TOROIDAL DISCHARGE APPARATUS. A. A. Schupp, H. K. Forsen, and D. W. Kerst (General Dynamics Corp., General Atomic Div., San Diego, Calif.). J. Nucl. Energy, Pt. C, 5: 161-7 (May-June 1963). (In English) (GA-3578)

Methods of distributing both the magnetizing and plasma-image currents at the gaps in toroidal geometry were studied in an effort to reduce the large transverse field errors generated by current flowing across these gaps. Improvements over simple toroidal geometry permitted a reduction in transverse field errors from 20 per cent of the external magnetizing field to less than 0.5 per cent. In addition, special distributions of currents and fields within the pinch were produced by programming the fields with special capacitor banks designed for this revised apparatus. (auth)

31594 STUDY OF THE INDUCTIVE DISCHARGE IN POSITIVE-ION SOURCES HAVING HIGH-FREQUENCY ELECTRICAL EXCITATION. André Degeilh (C.N.R.S., Toulouse) and Daniel Blanc. J. Phys., 24: 187-98(Mar. 1963). (In French)

Expressions are sought giving the values of the various parameters that are characteristic of the induction discharge in positive ion sources with radiofrequency excitation. After describing the mechanism of this discharge, the equations are found giving the magnetic and electric fields in the discharge space, when the displacement current is not negligible and in the special case where it may be neglected. The intensity and the phase of the induced electric field exerted on the inside wall of the discharge cylinder are calculated. Finally, from the equation of electron scattering, the distribution of the electron density and the electric conductivity inside the ionized gas are evaluated. (auth)

31595 MOTION OF CHARGED PARTICLES CONFINED IN A HELICALLY INVARIANT MAGNETIC FIELD. Hiroshi Itô (Osaka Univ.) and Nobuo Yajima. J. Phys. Soc. Japan, 18: 831-6(June 1963).

Approximate loci of the guiding center of a charged particle in a helically invariant magnetic field, in particular in a stellarator, were worked out. The rotational transform induces a kind of helical motion of the charged particle around the magnetic axis coupled with the curvature effect. Apparent centers of two dimensional paths projected on a section of the torus are different from the magnetic axis. These are situated on the line which passes through the center of curvature of torus and the position of the magnetic axis. $a\xi_c$, the position of the center of an eccentric path measured from the magnetic axis, becomes smaller for larger field strength, ripples of magnetic surface, and for smaller curvature. The sign of ξ_c depends on that of the charge and further on whether the velocity vector of the particle is parallel or antiparallel to the field vector. (auth)

31596 UNIFIED THEORY OF RELAXATIONS IN PLASMAS. I. BASIC THEOREM. Taro Kihara and Osamu Aono (Tokyo Univ.). J. Phys. Soc. Japan, 18: 837-51 (June 1963).

Two approximate theories—the impact theory and wave theory—of relaxation phenomena in hot plasmas are united into an exact theory, in which no cut-off procedure of the diverging integrals is needed, and which gives Coulomb logarithms with exact numerical factors in the arguments. When a relaxation rate is given by a diverging integral $\int B(b)db$ with respect to the impact parameter b in the impact theory and by a diverging integral $\int K(k)dk$ with respect to the wave number k in the wave theory, then the present theory gives the rate in the form $\int_0^\infty B(b) \exp(-\frac{1}{2} b^2/b_0^2)db + \int_0^\infty K(k) \exp(-\frac{1}{2} k^2 b_0^2)dk$. Here b_0 is any length much longer than the close impact radius but much shorter than the Debye radius; and the final results are independent of b_0. Simple examples are treated. (auth)

31597 THE ASSOCIATED ELECTRICAL INDUSTRIES LEVITRON. N. L. Allen, D. Balfour, V. C. Cloke, R. F. Hemmings, T. P. Hughes, B. Jordan, B. S. Liley, H. B. Mundy, R. M. Payne, and A. A. Ware (Associated Electrical Industries, Ltd., Aldermaston Court, Berks, Eng.). Nature, 199: 123-6(July 13, 1963).

The levitron is a toroidal version of the linear hardcore or inverse pinch discharge. The object of such machines is to produce hydromagnetically stable plasma, where the term hydromagnetic refers to those theories which assume infinite plasma conductivity. The geometry for this type of stability is reviewed and levitron operation is discussed. A sketch of levitron trigger sequence, plots of plasma density as a function of radius and time in the levitron, streak photographs of hydrogen discharge in the levitron, and results of magnetic probe measurements and calculations of energy containment times are presented. It is concluded that the containment properties of the normal levitron type discharge are superior to those of the pinch. (C.H.)

31598 ON THE DIFFERENCE BETWEEN THE AMPLIFICATION OF LONGITUDINAL PLASMA WAVES AND THE NEGATIVE ABSORPTION OF ČERENKOV RADIATION IN AN ELECTRON STREAM. R. Q. Twiss (Oxford and Cambridge Club, London). Phil. Mag. (8), 8: 1249-51 (July 1963).

Differences between the physical properties of the amplification of longitudinal space-charge plasma waves and the negative absorption of Čerenkov radiation are discussed. (D.C.W.)

31599 NUMERICAL CALCULATIONS AND COMPARISON WITH MEASUREMENTS INVESTIGATING THE INFLUENCE OF THE NEUTRAL GAS IN Θ-PINCH DISCHARGES. D. Duechs (Institut für Plasmaphysik, Garching, Ger.). Phys. Letters, 5: 121-5(June 15, 1963). (In English)

The previously used fluid model for a fully ionized plasma was extended for the calculations by adding continuity, momentum, and temperature equations for the neutral particles. Recombination, ionization, collisions, frictional heat, interchange of energy between particles, etc., were taken into account. Density and magnetic field measurements agree well with the theory. Results for initial degrees of ionization of 1 and 10% show that the absolute values of the densities, temperatures, velocities, and fields are greater for the larger value. (D.C.W.)

31600 EXPERIMENTAL RESULTS ON LIGHT SCATTERING BY A Θ-PINCH PLASMA USING A RUBY LASER. E. Fuenfer, B. Kronast, and H.-J. Kunze (Institut für Plasmaphysik, Garching, Ger.). Phys. Letters, 5: 125-7 June 15, 1963. (In English)

The polarized light of a ruby laser was focused on the center of the coil producing the Θ-pinch. Totally polarized scattered light was observed at right angles to the incident beam. The influence of plasma self-radiation on the measurements was avoided by splitting the scattered light into two beams, one of which contained the desired signal. At a plasma density of 10^{17} cm^{-3}, the ratio of scattered light to incident light was about $1:10^{11}$. An unexplained steep rise in the scattered signal was also observed. (D.C.W.)

31601 VALIDITY OF LOCAL THERMAL EQUILIBRIUM IN PLASMA SPECTROSCOPY. Hans R. Griem (Univ. of Maryland, College Park and Naval Research Lab., Washington, D. C.). Phys. Rev., 131: 1170-6(Aug. 1, 1963).

Criteria for the existence of local thermal equilibrium in various classes of plasmas are derived. In addition to general criteria that should also be fulfilled for homogeneous and time-independent plasmas, special criteria must be imposed on inhomogeneous and/or transient plasmas. The influence of the imprisonment of resonance radiation on the establishment of thermal equilibrium is considered, and it is concluded that even then complete thermal equilibrium can usually not be achieved for multiply ionized species. (auth)

31602 MAGNETODYNAMIC INSTABILITIES IN A PLASMA-BEAM SYSTEM. Jacob Neufeld and Harvel Wright (Oak Ridge National Lab., Tenn.). Phys. Rev., 131: 1395-1401(Aug. 15, 1963).

It is well known that Alfvén waves may be excited in a plasma-beam system. It is found in this investigation that such excitation is different for an ordinary (Alfvén-O) wave and for an extraordinary (Alfvén-X) wave. An Alfvén-O wave is characterized by a nonisotropic velocity distribution. However, the instability behavior for such a wave is found to be isotropic, i.e., the excited frequency and the rate of growth are independent of the direction of propagation of the wave. On the other hand, an Alfvén-X wave has an isotropic velocity distribution but its instability behavior is found to be nonisotropic. Expressions are derived for the excited frequency and the rate of growth corresponding to any direction of an Alfvén-O or Alfvén-X wave. An analysis is made of an excited Alfvén wave aligned along the direction of the magnetic field and a relationship given between the instabilities of linearly and circularly polarized waves. A comparison is made of instabilities produced by an electron and by an ion beam. (auth)

31603 COMPUTATIONS OF RADIAL DISTRIBUTION FUNCTIONS FOR A CLASSICAL ELECTRON GAS. David D. Carley (Univ. of Florida, Gainesville). Phys. Rev., 131: 1406-9(Aug. 15, 1963).

The radial distribution functions g for a classical electron gas computed using the Percus-Yevick (PY) equation, convolution hypernetted chain (CHNC) equation, and the Broyles-Sahlin (BS) method have been compared with the Debye-Hückel (DH) theory. The quantities $E \equiv \overline{U}/Nkt$ and $P \equiv p/nkT$ have been computed from these g's. Computations have been made for values of θ of 20, 10, 5, 3, and 1; $\theta = kTa/q^2$, where a is the ion sphere radius. The PY and BS results show the best agreement, particularly at $\theta < 3$. The BS method has been of particular value in this study of a long-range potential. In the range of θ studied, g never exceeds one, that is, there is no oscillatory behavior of g. (auth)

31604 ION CYCLOTRON RESONANCE AND THE DETERMINATION OF COLLISION CROSS SECTIONS. Darold Wobschall, John R. Graham, Jr., and Dennis P. Malone (Cornell Aeronautical Lab., Buffalo). Phys. Rev., 131: 1565-71(Aug. 15, 1963).

It is shown that the ion cyclotron resonance absorption line in weakly ionized gases may be interpreted to obtain e/m ratio, the number, and the collision frequency of the ions. From the observed linewidths, the collision frequencies of several ions are found as a function of pressure and electric field strength. From these data the ion-molecule collision cross section for N_2^+ and Ar^+ in their parent gases is found to be 125 and 140 $Å^2$, respectively, at high E/p and 185 and 215 $Å^2$, respectively, at low E/p. Observed absorption and dispersion line shapes fit closely the Lorentz line shape derived theoretically with the assumption of constant mean free time. The measurement chamber consists of an ion source and drift region in a strong magnetic field within which a transverse rf electric field may be applied. A narrow band, derivative-type system is used to detect the power absorption as a function of frequency. (auth)

31605 CAPTURE OF ELECTRONS BY MOLECULAR IONS. Robert C. Stabler (RCA Defense Electronic Products, Princeton, N. J.). Phys. Rev., 131: 1578-81(Aug. 15, 1963).

The (unimolecular) capture of thermal electrons by diatomic molecular ions through excitation of rotation is considered. Using an approximate form of the Coulomb wave functions, first-order theory, and a point-quadrupole perturbation, the cross section for capture of an electron with energy $\hbar^2k^2/2m$ into a bound state n ($E_n = -R_y/n^2$) is found to be $2\pi^3Q^2E_n\delta(E+|E_n|+E_J-E_{J+2})/25k^2$, where Q is the quadrupole moment in units of ea_0^2, and where E_J and E_{J+2} are the initial and final rotational energies. The rate of capture of electrons in an ionized gas where $T_e = T_i = 300°K$ is thus of the order $10^{-8} - 10^{-7}$ cm^3/sec. These captures take place into states of very high n which will come into equilibrium (through this and other processes) with the free electrons. It is not expected that these captures will make a significant contribution to the recombination rate but they may help to account for molecular spectra in recombining gases and enhanced rotational temperatures. (auth)

31606 DETERMINATION OF ATOMIC TEMPERATURE AND DOPPLER BROADENING IN A GASEOUS DISCHARGE WITH POPULATION INVERSION. C. K. N. Patel (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 131: 1582-4(Aug. 15, 1963).

The Doppler linewidth of the $5d[3/2]_1^0 - 6p[3/2]_1$ transition of xenon (Racah notation) at 2.026 μ in a helium-xenon discharge has been measured directly. Earlier, this transition has been shown to exhibit large optical amplification. The Doppler linewidth determination has been accomplished by measuring the optical gain in a helium-xenon discharge tube as a function of frequency. A short maser oscillator containing the same gas mixture is used as a tunable source of monochromatic radiation. The tuning has been accomplished by changing the length of the optical cavity and thus sweeping a cavity resonance across the Doppler-broadened gain curve. The source oscillator has been operated on a single longitudinal and transverse mode of the cavity to ensure as monochromatic source signal as possible. The measurements have yielded a Doppler linewidth of (210 ± 10) Mc/sec corresponding to an average atomic temperature of 515°K ± 10%. It is seen that the actual line shape measured coincides very closely to a pure Doppler broadening with a Doppler width of 210 Mc/sec. This indicates that for the $5d[3/2]_1^0 - 6p[3/2]_1$ transition of xenon, the primary source of broadening is Doppler broadening. From this, an upper limit has been assigned to the line broadening due to finite lifetime and due to isotope shift effects. (auth)

31607 EXPERIMENTAL RESULTS OF A BUMPY TORUS DISCHARGE. R. Geller (Stanford Univ., Calif.). Phys. Rev. Letters, 10: 463-5(June 1, 1963).

Bumpy geometry was used to control drift losses in BAGEL, which consists of a pulsed endless PIG arc in a toroidal tube. The optimal magnetic field configuration was obtained by trial and error. An ionization of 85% was obtained in Ar. Experimental values of the diffusion velocity determined from interferometric density measurements agreed surprisingly well with calculated values of the drift velocities. The results seem to support a classical diffusion behavior in the afterglow. (D.C.W.)

31608 MEASUREMENT OF THE THERMOELECTRIC POWER OF A FULLY IONIZED, LOW-TEMPERATURE PLASMA. N. Rynn (Princeton Univ., N. J.). Phys. Rev. Letters, 10: 465-7(June 1, 1963). (MATT-174)

The plasma generated in the Q-1 device by allowing a collimated beam of K to impinge upon a hot W plate is confined radially by a strong magnetic field and axially by hot plates. One plate was grounded while the other was allowed to float. The voltage generated in the thermocouple joints formed by the plasma, W plates, and voltmeter connectors as the temperature of the floating plate was varied permitted determination of the thermoelectric force as 3.8×10^{-3} volt/degree, in reasonable agreement with theory. (D.C.W.)

31609 VARIATION OF THE ELECTRON DENSITY ALONG A PLASMA COLUMN. B. Agdur, B. Keržar, and T. Nygren (Royal Inst. of Tech., Stockholm). Phys. Rev. Letters, 10: 467-8(June 1, 1963).

The electron density in a mercury discharge tube was measured as a function of distance from the cathode by the microwave cavity method at mercury temperatures of 10 to 60°C. The microwave cavity operated in the TM_{010} mode. At low plasma densities, the frequency shift for this mode depends only on the average plasma density; at high densities the distribution of the density also affected the shift. (D.C.W.)

31610 MEASUREMENT OF ELECTRON DENSITY AND TEMPERATURE IN DENSE PLASMAS BY APPLICATION OF LINE BROADENING THEORY. J. B. Shumaker, Jr. and W. L. Wiese (National Bureau of Standards, Washington, D. C.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 575-9 (1962).

The results indicate that electron densities accurate to 10

or 15% can easily be obtained from the measurement of line profiles of hydrogen. No knowledge of the amount of hydrogen present is required, and the application of the technique is independent of the presence of local thermodynamic equilibrium (LTE). The determination of the temperature from the electron density requires LTE and a rather detailed knowledge of the energy levels and amounts of the elements present. This method is of advantage in those cases where the hydrogen negligibly affects the plasma and is present in small concentrations. The hydrogen then behaves as a true thermometer. (auth)

31611 PLASMA TEMPERATURE: RELATIVE INTENSITY OF SPECTRAL LINES. W. E. Hill (General Electric Co., Schenectady, N. Y.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 581-5(1962).

Successive temperature measurements on the plasma jet, which is adjusted to similar conditions, indicate that the precision of this method is within ±1% in the temperature range of 5000 to 6000°K. This precision is attributed to the adopted technique of placing both calibration information and test data on each spectrograph plate and thus eliminating the photographic variables. (auth)

31612 DETERMINATION OF PROPERTIES OF AN OPTICALLY THIN ARGON PLASMA. H. N. Olsen (Linde Co., Indianapolis). Temp. Meas. Control. Sci. Ind., 3: Pt. 1, 593-606(1962).

On the assumption of local thermodynamic equilibrium, the composition of an electric-arc Ar plasma is calculated, and the plasma temperatures are determined at 10,000 to 23,000°K, using these compositions and measured radiation intensities. Values of atomic and ionic transition probabilities are determined from measured radiation intensities. Measurements are made of the temperature dependence of the electric conductivity, radial temperature and current-density distributions, electric field intensities, potential and electrode drops, and electron drift velocities. (T.F.H.)

31613 THE MEASUREMENT OF HELIUM OSCILLATOR STRENGTHS USING AN ELECTROMAGNETIC SHOCK TUBE. E. A. McLean (Naval Research Lab., Washington, D. C.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 607-11 (1962).

An electromagnetically driven, T-shaped shock tube is filled with He to a pressure of 1 to 5 mm Hg, and a shock wave is produced by discharging a capacitor in the tube. The plasma thus produced is found to be in local thermodynamic equilibrium, and temperatures of 20,000 to 45,000°K can be produced. The intensities of the He emission lines are measured, and these intensities are used to compute the oscillator strengths for several of the lines. (T.F.H.)

31614 MEASUREMENT TECHNIQUES IN HIGH-ENERGY PLASMAS. Hans R. Griem (Univ. of Maryland, College Park and Naval Research Lab., Washington, D. C.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 615-27(1962).

The determination of electron and ion temperatures and densities in plasmas having energies above some 100 ev, by means of measurements of continuum intensities, line intensities, line profiles, relative and absolute x-ray intensities, equilibrium ionizations, ionization times, Doppler widths, bremsstrahlung, and Stark widths, is reviewed. (T.F.H.)

31615 THE USE OF THE SPECTRAL LINE MEDIAN IN DETERMINING PLASMA TEMPERATURES. Harry Sadjian (General Electric Co., Philadelphia). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 629-42(1962).

Assuming that the area under a Stark-broadened emission line in a plasma remains constant as the width increases, the plasma temperature is calculated from the broadening. The validity of the calculation is shown by a general recourse to line-broadening theory. Experimental results on He and Li lines are shown as examples. (T.F.H.)

31616 ION ENERGY EVALUATION FROM SPECTRUM LINE CONTOURS. P. M. Griffin, J. R. McNally, Jr., and G. K. Werner (Oak Ridge National Lab., Tenn.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 651-61(1962).

The Doppler broadening of spectral lines in electric-arc plasma is used to calculate the velocity distributions and energies of the plasma ions. Graphical and least-squares fitting of the experimental data to Gaussian curves is discussed. (T.F.H.)

31617 PLASMA TEMPERATURES BY SPECTROSCOPY IN THE X-RAY REGION. T. F. Stratton (Los Alamos Scientific Lab., N. Mex.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 663-78(1962). (TID-12331; LADC-4806)

The continuum radiation (black-body, bremsstrahlung, and recombination radiation) and line radiation characteristics of plasma in the 10^6 °K range are described. Because the most intense radiation for such plasmas falls in the x-ray region, the uses of x-ray spectrometry for plasma temperature measurements becomes feasible. The thermometric uses of x-ray detectors and spectrum analyzers are described and expounded. (T.F.H.)

31618 ELECTRON TEMPERATURE MEASUREMENTS ABOVE 100,000°K USING RADIATION AT THE ELECTRON CYCLOTRON FREQUENCY. W. B. Ard, Jr. (Oak Ridge National Lab., Tenn. and Univ. of Florida, Gainesville). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 679-84(1962).

While it seems to be very difficult in practice to determine electron temperature by radiation measurements with any accuracy, it does appear that this method affords the possibility of estimating relative variation in temperature under different arc conditions. Even though the method is crude as far as quantitative measurements are concerned, sometimes even these crude measurements are the most reliable quantitative measurements obtainable. For instance, the measurement of electron energies transverse to strong magnetic fields with electrostatic probes is almost meaningless. Optical spectroscopy is also of little use in a highly ionized hydrogen plasma, particularly if the electron energies are very high. (auth)

31619 PLASMA DIAGNOSTICS WITH THE AID OF CYCLOTRON RADIATION. Ludwig Oster (Yale Univ., New Haven). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 685-7(1962).

The determination of the temperature of a plasma (and incidentally of the particle distribution functions in the plasma) from the cyclotron radiation spectrum emitted by the plasma is studied. The plasma is assumed to be relativistic. (T.F.H.)

31620 BREMSSTRAHLUNG FROM AN IONIZED PLASMA IN THE RADIO FREQUENCY RANGE. Ludwig Oster (Yale Univ., New Haven). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 689-90(1962).

Classical and quantum calculations are made of the r-f spectral coefficients, r-f absorption and emission coefficients, and r-f conductivity of plasma. It is assumed that the plasma is totally ionized, that no external magnetic fields exist, that the particles are nonrelativistic, and that the r-f radiation considered is so far above the plasma frequency that the effective refractive index of the plasma in the r-f region is unity. (T.F.H.)

31621 TEMPERATURE MEASUREMENT IN PLASMAS BY THERMAL NEUTRON SCATTERING. R. E. Barr, R. R. Boedeker, R. M. Delaney, P. D. Doherty, D. J. Manson, and

A. H. Weber (St. Louis Univ.). Temp. Meas. Control Sci. Ind., 3: Pt. 1, 691-5(1962).

Experiment indicates that the effect of plasma temperature on the energy distribution of the scattered neutrons is about as predicted. (auth)

31622 EFFECT OF THE MAGNETIC FIELD ON SPACE PERIODICITY IN THE PLASMA OF A GASEOUS DISCHARGE. F. D. Kochanov. Tr. Kuibyshevsk. Aviats. Inst., No. 12, 385-91(1961).

Experimental results are presented of a study on the effect of a longitudinal magnetic field upon the spatial periodicity of standing layers in a positive column of a gaseous discharge. It is shown that, with increasing intensity of magnetic field H, the spatial period first increases up to a certain limiting value, then starts to decrease. Similarly, the plasma conductivity varies along the direction of the magnetic field. Temperature of the electron gas decreases with increase of the magnetic field intensity (according to measurements up to a critical value). It is shown that the variation of space-periodicity of the positive column can be explained satisfactorily from the point of view of the diffusion theory of layers. (Referativnyy Zhurnal, Nekhanika, No. 8, 1962).

31623 ON THE ENERGY SPECTRUM OF THE ISOTROPIC HYDROMAGNETIC TURBULENCE. E. Richter (Universität, Kiel). Z. Physik, 174: 314-25(1963). (In German)

The physical consequences emerging from a theory stated by Kraichnan are considered with regard to isotropic hydromagnetic turbulence. This theory involves the direct-interaction approximation retaining the phase correlation within each triad of Fourier amplitudes. These interactions are suggested to be very important in hydromagnetic turbulence. Hydrodynamic as well as magnetic impulse-response function and time-correlation are unequivocally the same. This result suggests the existence of a universal equilibrium range. Within the inertial range the total energy spectrum $E_g(k) = E(k) + E_m(k)$ obeys the same law as in hydrodynamic turbulence E(k). The value $E_m(k) \approx E(k)$ corresponds roughly to maximum energy flux through this range. The magnetic energy flux decreases rapidly for eddies with larger wave-numbers within the range of ohmic $\gg$ viscous dissipation. (auth)

31624 IONIZATION EQUATION FOR PLASMA IN THE INTERMEDIATE TEMPERATURE AND DENSITY REGION. W. L. Bohn (Technische Hochschule, Aachen). Z. Physik, 174: 383-8(1963). (In German)

By evaluation of classical rate coefficients for ionization and recombination in a plasma a modified ionization formula is given for the intermediate range of electron temperature and density which is of interest for laboratory experiments. In accordance with recent spectroscopic measurements another ionization formula is discussed using the cross sections of Bates and Kingston. This formula meets the physical phenomena better than previous calculations. In hydrogen it yields the tenfold value for the neutral plasma component as would be expected from the Saha equation. (auth)

31625 KUBO FORMALISM FOR THE CONDUCTIVITY OF A PLASMA WITH RANDOM SCATTERERS. Charles R. Willis (Boston Univ.). 58p. (CONF-38-5)

From American Physical Society Meeting, Atlantic City, N. J., Nov.-Dec. 1962.

Kubo's theory of conductivity is applied to a model of a classical plasma that consists of treating the discreteness of the positive ions as a small perturbation on a system of charges neutralized by a uniform background of positive charge. An equation that approaches equilibrium monotonically as a consequence of the assumption that the adiabatically "switched on" ions have a random distribution of positions is derived. The derivation is rigorous in the limit that the graininess of the positive charge vanishes. The equation is then applied together with the Kubo theory to various calculations of the conductivity. The low frequency behavior of the conductivity is found to be strongly influenced by the positive ions, but the high frequency behavior is relatively unaffected except for long wavelength oscillations in the neighborhood of the plasma frequency. Expanding the conductivity using the Bogoliubov solution of the hierarchy gives the usual expression for homogeneous plasmas at low frequencies; and, at high frequencies, the linearized equations agree with the results of Dawson and Oberman. (auth)

31626 PLASMA PHYSICS AND MAGNETOFLUIDMECHANICS. Ali Bulent Cambel. McGraw-Hill Series in Missile and Space Technology. New York, McGraw-Hill Book Co., Inc., 1963. 316p. $11.50.

A review of electromagnetic field theory is presented. The physical chemistry of plasmas including reaction kinetics, thermodynamics, and transport phenomena is discussed. The fundamentals of fluidmechanics as modified by electromagnetic fields are also considered. Topics covered include concepts of magnetofluidmechanics, electricity and magnetism, plasma wave phenomena, ionization and deionization, thermodynamics of real gases, transport phenomena, flow equations of magnetofluidmechanics, and applications of magnetofluidmechanics. (C.E.S.)

31627 GYRO-INTERACTION OF MICROWAVES IN MAGNETO PLASMAS IN NOBLE GASES. K. V. Narasinga Rao and L. Goldstein (Univ. of Illinois, Urbana). 15p. (CONF-70-1)

From National Symposium of the Professional Technical Group on Microwave Theory and Techniques, Santa Monica, Calif., May 1963.

The technique of interaction of guided electromagnetic waves in magnetoplasmas is utilized to study the phenomena resulting from the cyclotron resonance ($f = f_H$ = gyrofrequency of electrons) absorption of microwave energy by the electron gas. The enhancement in electronic energy caused by this absorption is experimentally evidenced by the study of gyro-interaction of microwaves of different frequencies ($f_1 \leq f_H \leq f_2$), emission of microwave noise power at frequencies $f_n \geq f_H$, intensity of visible light excitation, and rapid disintegration of the plasma. A correlation of these experimental results show that the rate of heating of any specific region of the plasma changes drastically during different time intervals of the pulsed resonant heating microwave signal and that non-uniform heating occurs along the plasma axis. Implication of these results on wave propagation in a magnetoplasma are discussed. (auth)

31628 LONGITUDINAL INSTABILITIES IN AN ELECTROSTATIC PROPULSION BEAM WITH INJECTED CURRENT NEUTRALITY. D. A. Dunn and I. T. Ho (Stanford Univ., Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63041, 13p. (CONF-10-6).

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The one-dimensional static theory of electrostatic propulsion with injected-current neutrality predicts a steady return current of electrons, if the electron velocity exceeds about twice the injected ion velocity. A one-dimensional

model similar to that of Buneman and of Dawson using individual electron and ion sheets was used to calculate electron and ion trajectories for the case of electrostatic propulsion with injected current neutrality, using a computer. It is found that, in all cases in which the static theory predicts a d-c return current, the present model predicts oscillations near the electron plasma frequency at the position of greatest electron density. No oscillations are found, if the static theory predicts uni-directional flow of both electrons and ions. The amount of returned electron current is found to be different in the presence of oscillations from the results of static theory and a comparison is given for the cases calculated. The ion trajectories can also be drastically altered from those predicted by static theory for large ratios of electron to ion velocity and ions can return to the ship. Trajectory plots for both electrons and ions for a number of critical cases are compared with the results of static theory. These results are related to and consistent with results for oscillations in electron diodes above limiting perveance. All of the calculations presented are for the case of electrons and ions injected as single velocity beams, i.e., the thermal velocity spread of the electrons is not taken into account. A result of the oscillations predicted in this theory is effectively to thermalize the electrons that were injected at a single d-c velocity, so that the behavior of the streams far from the ship may be similar to the behavior with a thermal spread included as an initial condition. (auth)

31629 ELECTRON DISTRIBUTIONS IN A PLASMA JET AT LOW PRESSURE. Robert Barker Gaither. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 145p.

An electrically energized plasma jet of Ar at low pressure (20 to 40 mm Hg) and low degrees of ionization ($\sim 10^{-8}$) was studied and found to be amenable to both theoretical and experimental analyses. Shielding of the jet provided a field free and steady plasma jet flow. A method of analysis was developed that took into account electron thermal conduction and ambipolar diffusion in the constant velocity core region of the jet. The results were in close agreement with the experimental measurements. The experimental data were collected using the conventional techniques of gas dynamics and a Langmuir probe. Accurate determination of electron thermal conductivity and ion mobility was made semi-empirically. The data are in good agreement with published results of transient measurements. (auth)

31630 COUNTERROTATING PLASMA DEVICE. Klaus Halbach, W. R. Baker, and D. Veron (to U. S. Atomic Energy Commission). U. S. Patent 3,096,269. July 2, 1963.

An ion-electron plasma device having a conductive, cylindrical casing provided with an axially directed magnetic-mirror-type field is described. An axially aligned tubular electrode is disposed at each end of the casing with oppositely directed radial electric fields provided between each electrode and the casing. Simultaneous pulses of gas, injected from the inner end of each of the electrodes, become ionized and oppositely rotating plasma bodies are formed. The magnetic mirrors repel the plasma bodies and cause them to collide in the region between the mirrors. The opposite directions of rotation of the plasma bodies cause very high currents to flow therebetween and consequent heating occurs. (AEC)

31631 APPARATUS FOR THE MASS ANALYSIS OF PLASMA ON A CONTINUOUS BASIS. R. V. Neidigh (to U. S. Atomic Energy Commission). U. S. Patent 3,096,438. July 2, 1963.

An apparatus for the mass analysis of plasmas on a continuous basis is described. The apparatus comprises a pair of parallel electrodes in a tubular member which serve as a velocity-selecting region for ions drawn by an accelerating potential through a tapered nose cone affixed to the tubular member. The magnetic force and electrostatic forces in the velocity-selecting region are made equal and opposite in direction to prevent the ionic species from striking either of the electrodes as they traverse the region. A pair of parallel plates is positioned within the tubular member and in alignment with the electrodes, but displaced slightly so as not to be seen by direct light coming through the entrance slit of the nose cone, and one of these plates serves as a collector plate. This collector plate is coupled to the vertical amplifier of an oscilloscope or other recorder to provide a continuous indication of the ionic composition of the plasma under analysis. (AEC)

31632 A DEVICE FOR DETERMINING THE TEMPERATURE OF PLASMA BY THE METHOD OF SPECTRAL-LINE REVERSAL. G. A. Boberskii. Russian Patent 148,551. June 7, 1961.

A pulse tube used in devices for measuring the temperature of plasma by the method of spectral-line reversal is described. It raises the upper limit of temperatures that can be measured. (TCO)

Shielding

Refer also to abstracts 29972, 29973, 29992, and 30066.

31633 (ASD-TDR-63-194) ELECTROMAGNETIC SHIELDING FEASIBILITY STUDY. Robert F. Tooper (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Jan. 1963. Contract AF33(616)-8489. 143p.

The shielding of personnel against charged particles in space using electric or magnetic fields is examined. The energy distribution and other characteristics of charged particles in space are summarized. The operation and stability of an electrostatic shield (two concentric charged conducting spheres) for protection against 1-Mev electrons and 500-Mev protons is discussed. Shielded regions for charges in a magnetic dipole field are described. A method is given for calculating trajectories of particles incident on a magnetic dipole in a parallel beam, with sample trajectories illustrated. The vector potential of a cylindrical solenoid is used to get the shielded region for $L/R = 1.00$, $R/C_{ss} = 0.40$. The mass of conductors and structure of superconducting solenoids are calculated in terms of the geometry and dipole moment. A non-optimum sample has a magnetic moment 5.66×10^{12} gauss cm^3, radius and length 4 meters, weighs 417,000 lb, and protects ~50 $meters^3$ from 1-Bev protons. A single-turn magnetic shield could be made $^1/_{10}$ the mass of a comparable passive shield for 1-Bev protons. Structural considerations and preliminary shielded volume studies indicate that further decrease in mass could be obtained using an optimized cylindrical solenoid. Recommendations for future work emphasize further studies of cylindrical solenoids and other current configurations. (100 references) (auth)

31634 (NAA-SR-Memo-8516) ANALYTIC TECHNIQUES FOR THE CALCULATION OF THE ORNL TOWER SHIELD EXPERIMENTS. PART II, ANNEX-2. R. S. Hubner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 20, 1963. Contract AT(11-1)-Gen-8. 117p.

Program ANNEX-2 is described. It is a modified version of ANNEX-1, a Monte Carlo method of analysis of neutron scattering from cylindrical volume. Detector biasing techniques were included insuring that every neutron scattering event for every history contributed to the flux at the detector; thus each neutron history not only contributes to the flux at the detector, but also contributes to several energy groups of the detector spectrum. The energy group structure is filled up more rapidly than in ANNEX-1 resulting in much shorter running times for the same degree of convergence. Program restrictions, operation, and input are the same as for ANNEX-1. (auth)

31635 (ORNL-3466) TABULATED VALUES OF SCATTERED GAMMA-RAY FLUXES IN WATER INTERPOLATED FROM MOMENTS METHOD CALCULATIONS. D. K. Trubey (Oak Ridge National Lab., Tenn.). July 29, 1963. Contract W-7405-eng-26. 82p.

Tables of scattered gamma-ray fluxes in water that are suitable for integration over source spectra were generated on the IBM-7090 computer by Lagrangian interpolation of moments method results for point isotropic gamma-ray sources. Values of the fluxes were obtained for a consistent set of scattered gamma-ray energies taken in steps of 0.1 Mev from 0.1 to 1.0 Mev and in steps of 0.25 Mev from 0.25 to 10 Mev. One table was obtained for each scattered energy for various values of the source energy and of the distance from the source in mean free paths. Tables were then generated in which the distance from the source was converted from mean free paths to centimeters. The latter set may be integrated over any source spectrum to obtain the flux of scattered gamma rays in water, and, with small error, in any material in which the cross section is dominated by the Compton scattering cross section. This includes the low-Z materials such as aluminum and air. (auth)

31636 (UCRL-4047) EFFECT OF BORON LINER ON NEUTRON BACKGROUND IN CAVITY. Jack Benveniste (California. Univ., Livermore. Radiation Lab.). Jan. 16, 1953. Contract [W-7405-eng-48]. 14p.

In connection with conducting neutron experiments in a pit with earth and concrete walls, it was proposed that the background flux of neutrons might be reduced by lining the walls of the pit with a neutron absorber such as boron. Measurements were made to determine how much liner material would be desirable and what diminution in the neutron background could be expected. It was found that there was no benefit in using a boric acid layer deeper than ½ in. Further, this lining may be expected to reduce considerably the slow-neutron flux in the cavity but to affect the fast-neutron level hardly at all. (M.C.G.)

31637 A LEAD SHIELDING FOR MEASUREMENT OF MINUTE γ-ACTIVITIES IN LARGE SAMPLES. O. Paakkola and H.-J. Steinert (Physikalischen Institut der Bundesversuchs- and Forschungsanstalt für Milchwirtschaft, Kiel). Atompraxis, 9: 232-5(June 1963). (In German)

A specially designed lead shield is described for use in γ spectrographic measurements of low-level activity in samples of up to about 6 liters. With a 5-in. by 5-in. scintillation crystal it is possible to measure activities of 5 pc/l in contaminated milk. The specific activity of different lead samples was measured. (C.H.)

31638 COMPOSITION OF MATTER USEFUL AS A NEUTRON ATTENUANT. (to Goodyear Tire and Rubber Co.). British Patent 925,505. May 8, 1963. Priority date May 27, 1959, United States.

Neutron shielding material is patented, which consists of a major proportion of solid particles of polyethylene or polypropylene and a minor proportion of a pourable, settable organic binder. To secure high packing factors, the polyethylene particles should be substantially spherical and of at least 3 discrete sizes, which vary from size to size by a factor of 10 and preferably by a factor of 100. The binder may be of a variety of vulcanizable elastomeric materials, one recommended material being a copolymer of butadiene and methacrylic acid. Minor proportions, up to 10% by weight, of high-neutron-absorptive materials such as B, Li, or Cd should be incorporated in a homogeneous dispersion throughout the shield. The shielding material is pourable, castable, and can absorb physical shock with a minimum risk of fracture. (M.P.G.)

31639 A NEW OR IMPROVED SHIELDING MATERIAL. William Waddell Robson and Ames Gresley Hellicar (to Associated Lead Mfg. Ltd.). British Patent 926,006. May 15, 1963. Filed July 26, 1960.

A covering or lining for nuclear reactors or other vessels is patented. The covering is composed of rigid slabs having interlocking stepped edges and holes to accommodate bolts for fastening the slabs to the wall of the vessel. The slabs fit together with their stepped edges overlapping without being mutually joined, so that certain slabs are directly removable from the wall. The slabs consist of integral or separable layers and have 2 configurations, a square truncated pyramid and an oblong with outwardly presented steps on 2 opposite sides and inwardly presented steps on the other opposite sides. The invention is primarily concerned with lead shielding for nuclear reactors but might also be made of ceramic material for the inner lining of a chemical plant. (M.P.G.)

Theoretical Physics

31640 (NP-12975) PROCEEDINGS OF THE MIDWEST CONFERENCE ON THEORETICAL PHYSICS, JUNE 1-2, 1962, MEETING HELD AT ARGONNE NATIONAL LABORATORY, ARGONNE, ILLINOIS. (Argonne National Lab., Ill.). 182p.

Fourteen papers on particle interactions, scattering, quantum electrodynamics, the electromagnetic vector potential, conform-invariant theory, field theory, bremsstrahlung from single crystal targets, uncertainty relation weakening in high-energy scattering, and elementary particle theory are included. Separate abstracts were prepared for thirteen papers; the other paper was previously abstracted in NSA. (D.C.W.)

31641 (NP-12975(p.1-13)) ON THE "REALITY" OF ELECTROMAGNETIC VECTOR POTENTIAL. Murray Peshkin (Argonne National Lab., Ill.).

Aharonov and Bohm proposed that the reality of the vector potential could be studied by scattering a spinless electron from an impenetrable cylinder in an externally fixed magnetic field. The contained flux affects the kinetic angular momentum of the electron. The implication for quantum electrodynamics is considered briefly. It is maintained that the electromagnetic field where the electron moves can not be ignored as Aharonov and Bohm did and that their conclusion that the vector potential must be viewed as a dynamical quantity arose from their assumptions about the field dynamics. (D.C.W.)

31642 (NP-12975(p.14-25)) ANALYSIS OF THE INELASTIC SCATTERING OF ALPHA PARTICLES. G. R. Satchler (Oak Ridge National Lab., Tenn.).

An attempt is made to understand why the distorted-

waves method and collective model provide such good agreement with experiment for alpha inelastic scattering by nuclei. The oscillatory nature of the angular distributions is shown to originate in a strong localization in angular momentum space, and the Blair phase rule is shown to follow from related considerations. The relation between elastic and inelastic scattering is also considered. (D.C.W.)

31643 (NP-12975(p.26-36)) FORMULATION AND MEANING OF CONFORM-INVARIANT THEORY. F. Rohrlich (Iowa. State Univ., Iowa City).

Conformal transformations are defined, and a mathematical formulation with which to deal with conformal invariance, both in general and special relativity, is indicated. Equations and quantities of physics are then examined for invariance, and the meaning of their invariance is discussed. Particular attention is given to acceleration transformations, the constant homogeneous gravitational field, and geodesics. (D.C.W.)

31644 (NP-12975(p.37-75)) PANEL DISCUSSION: DIFFERENT APPROACHES TO THE PHYSICAL AND MATHEMATICAL DESCRIPTION OF PARTICLES, FIELDS, AND THEIR INTERACTIONS. R. Haag, S. Frautschi, and A. Wightman.

Efforts in field theory, S-matrix theory, and the relation between fields and the S operator are discussed. Recent developments are pointed out. (D.C.W.)

31645 (NP-12975(p.76-81)) A DISPERSION APPROACH TO THE SELECTION RULE $|\Delta I| = \frac{1}{2}$. K. Nishijima (Illinois. Univ., Urbana).

Derivation of the slection rule $|\Delta I| = \frac{1}{2}$ in the nonleptonic decays of strange particles, for which much experimental evidence has been obtained, is examined. Lagrangian theory is shown to be unable to give a good account of weak interactions, and the formulation of weak interactions in terms of unsubtracted dispersion relations for all the weak decay amplitudes is considered. Consideration of the nonleptonic decay of hyperons shows that the rule may arise as a consequence of the charge independence of strong interactions. (D.C.W.)

31646 (NP-12975(p.82-92)) PION-HYPERON RESONANCES WITH SMALL π-Σ-Σ COUPLING. J. Franklin (Brown Univ., Providence). (TID-14932)

Predictions of the static dispersion model for $f_\Sigma \sim 0$, where f_Σ is the static model π-Σ-Σ coupling constant, are examined. The static model of π-Y scattering with $f_\Sigma = 0$ is considered. Approximate solutions to the scattering integral equations are investigated, and the results of a computer solution are presented. The results indicate an $I = 1$, $J = \frac{1}{2}$ π-Σ resonance and have the $I = 0$ resonance above the $I = 2$ resonance. However, for f_Σ small enough a Y_0^* is predicted, perhaps within 20 Mev above the Y_1^*. (D.C.W.)

31647 (NP-12975(p.93-114)) NON-WEAK-COUPLING METHOD IN MESON THEORY. Helmut Jahn (Iowa. State Univ., Iowa City).

Intermediate and strong coupling methods are considered in developing a procedure for explicitly obtaining nucleon isobars from a meson-theoretical model. The model is discussed, and the methods are used to obtain a suitable operator representation of the physical nucleon state and the scattering states. The excitation and decay of isobars with pion production can be described, as can the meson-nucleon resonance scattering. (D.C.W.)

31648 (NP-12975(p.115-19)) GEOMETRIC THEORY OF CHARGE AND BARYON NUMBER. H. Ekstein (Argonne National Lab., Ill.).

Improvements in the theory, and its bases and predictions, are briefly discussed. The theory is noted to explain some aspects of charge through space-time considerations and to indicate that a baryon (charged or neutral) will have a coparity opposite the -1 coparity for positronium in the ground state. (D.C.W.)

31649 (NP-12975(p.120-6)) REGGE POLES. R. G. Newton (Indiana Univ., Bloomington).

Considering the S-matrix elements as an analytic function of the complex angular momentum and considering the angular momentum as a continuous, even complex, variable leads to interesting results. Consideration of the angle in the complex λ-plane at which the zero trajectory leaves the real axis at $E = 0$ shows that the trajectory osculates the real axis more closely the higher its outward angular momentum. The noted infinite number of zero trajectories in the right-hand half plane of $l = \lambda - \frac{1}{2}$ for a certain attractive potential is shown to come from the left. Every negative integer l is found to be a possible end point of a trajectory. The symmetry relation for $S(\lambda,K)$ and $S(-\lambda,K)$ is examined, and S is found to have no pole or zero at $\lambda = -\frac{1}{2}$ N and not necessarily at $\lambda = \frac{1}{2}$ N. A possible trajectory end point at $J = -\frac{1}{2}$ was found in considering a spin $-\frac{1}{2}$ particle scattered from a spin $-\frac{1}{2}$ particle. (D.C.W.)

31650 (NP-12975(p.133-43)) UNIFIED HAMILTONIAN THEORY OF RELATIVISTIC PARTICLE EQUATIONS. Eugene Guth (Oak Ridge National Lab., Tenn.).

A unified equation is derived for the Zitterbewegung of the space coordinate. Using Hamilton's canonical equations of motion, the explicit structure of the linear hamiltonian for spins 0, $\frac{1}{2}$, and 1 is derived. The spin-dependent aspects of the Zitterbewegung and the Spinbewegung are noted to show up in the time-dependence of the hypercomplex operators represented by the matrices. The interdependence of the equations of the motion and of the commutation relations is discussed. (auth)

31651 (NP-12975(p.144-61)) AN APPARENT WEAKENING OF THE UNCERTAINTY RELATIONS FOR PROTON-PROTON SCATTERING ABOVE 10 Bev AND ITS POSSIBLE CONNECTION WITH ELECTRON-PROTON SCATTERING. Eugene Guth (Oak Ridge National Lab., Tenn.).

The reported diffraction peak sharpening in the differential cross section for p-p scattering is noted to be in agreement with a weakening of uncertainty relations at high energy. Deviations in the Rosenbluth formula for e-p scattering may also occur (if this is the case) at high energies. Possible connection between Regge theory and uncertainty weakening are discussed, and an uncertainty relation (nonrelativistic example) passing into certainty at high energies and reducing to the usual quantum limit for low energies is illustrated. Construction of a relativistically invariant commutation relation for interpreting high-energy p-p experiments is briefly considered. (D.C.W.)

31652 (NP-12975(p.162-9)) INFRAPARTICLES. B. Schroer (Illinois. Univ., Urbana).

Infraparticles are explained by considering their relation to the usual concept of a particle in quantum field theory, and the infraparticle situation for a solvable field-theoretical model is examined. The possibility of their occurrence in quantum electrodynamics is considered. (D.C.W.)

31653 (NP-12975(p.170-9)) QUANTUM ELECTRODYNAMICS WITHOUT UNPHYSICAL PHOTONS. F. Rohrlich (Iowa. State Univ., Iowa City).

The theory of quantum electrodynamics is formulated in terms of field strengths, starting from Maxwell's equations and obtaining the basic equations of quantum electrodynamics. This formulation eliminates many unphysical features of the other formulation and may be renormalized just like the other theory. The formulation shows the sufficiency of asymptotic Lorentz invariance. Nonlocal, nonlinear field equations, a positive definite metric, and nonlocal commutation relations for the renormalized field arise from this formulation. (D.C.W.)

31654 (PAN-384/VII) NEUTRINOS IN SUPERDENSE MATTER. I. A TENTATIVE STATISTICAL APPROACH. Bronislaw Kuchowicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1963. 34p.

The neutrino gas is discussed in a standard statistical approach which may be of some value for certain high-density objects like neutron-hyperon matter bulks proposed by Ambartsumian. Formulas for neutrino number density and energy are derived for the general case and approximate formulas, valid with an accuracy of the order of half a percent, are obtained for complete and weak degeneracy of the neutrino gas. Numerical calculations are done for neutrino gas parameters in the region where the approximate formulas from above cannot be used with sufficient accuracy. The dependence of the neutrino number density on temperature for different values of the chemical potential (from +10 Mev to −5 Mev) is presented in the form of a diagram. (auth)

31655 LINEAR VELOCITY-GRADIENT TERM IN TIME-DEPENDENT PAIR DISTRIBUTION FUNCTION. R. E. Nettleton (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 38: 1791-1802(Apr. 15, 1963).

A Chapman-Enskog-type perturbation solution, in gradients of energy, velocity, and density, is proposed for the hierarchy of intergo-differential equations obeyed by the time-dependent Ursell-Mayer functions. The hierarchy is then terminated by an ansatz relating the three-particle Ursell functions to those of lower order, which yields a closed system for the perturbations to the singlet and pair distribution functions (it is assumed the equilibrium functions are known). Attention is focused on the equation for the two-particle functions, and on the term therein proportional to the divergence of fluid velocity, from which the bulk viscosity may be calculated. An expansion for this term is assumed in powers of scalar products of particle separations and velocities, in which the coefficients in turn are expanded in Sonine polynomials in the velocities. The functions which multiply these polynomials satisfy a system of integral equations, for which a first approximation is written down and the solution discussed. Finally, it is shown that substitution of the solution for the pair distribution function into the hierarchy equation for the singlet distribution yields an infinite number of conditions which may be used to evaluate a corresponding number of parameters in the ansatz employed to close the hierarchy. (auth)

31656 ONE-DIMENSIONAL FERMION DENSITY FORMULA. Herbert Payne (Wright-Patterson Air Force Base, Ohio). J. Chem. Phys., 38: 2016-19(Apr. 15, 1963).

An expression for the sum of the position-probability densities for a one-dimensional system of fermions in the ground state is derived from wave mechanics. Its accuracy in application to three different potential-energy functions is shown. For the square well of infinite height it preserves the sinusoidal contributions which disappear in the corresponding Fermi-Thomas treatment. Where the potential energy exceeds the Fermi level, it is properly characterized. (auth)

31657 EXTENSION OF LEVINSON'S THEOREM TO THE RELATIVISTIC CASE. Robert L. Warnock (Illinois Inst. of Tech., Chicago). Phys. Rev., 131: 1320-9(Aug. 1, 1963).

A generalization of Levinson's theorem is proved. The proof requires that the elastic partial-wave scattering amplitude satisfy a dispersion relation, and that the N/D integral equation be of Fredholm type with nonzero determinant. Inelastic processes are taken into account fully by means of a complex phase shift. The high-energy behavior of the imaginary part of the phase shift is subject to mild restrictions. For spinless particles the theorem states that $\delta_l(\infty) = (-n_b + n_c)\pi$. The real part δ_l of the phase shift is normalized to zero at threshold. n_b is the number of "particle poles"; i.e., elementary particle poles or bound state poles of the amplitude. n_c is the number of Castillejo-Dalitz-Dyson (CDD) poles of the D function. An unfamiliar aspect of the CDD ambiguity is discussed. For complete generality in computing particle poles from a given left cut discontinuity, a new sort of CDD pole must be admitted at real energies below threshold. This type of pole is to be associated with a stable particle with energy below threshold, whereas an ordinary CDD pole corresponds to an unstable particle above threshold. (auth)

31658 ASYMPTOTIC INVARIANTS IN GRAVITATIONAL RADIATION FIELDS. J. N. Goldberg (Aeronautical Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev., 131: 1367-78(Aug. 1, 1963).

Asymptotic integral invariants are constructed for the electromagnetic and gravitational fields. The integrals are taken over closed two-dimensional surfaces embedded in a null hypersurface. In the absence of incoming radiation the asymptotic behavior of the electromagnetic field F^{ab} and the Riemann tensor R^{abcd} is such that the integrals formed with these quantities are independent of the particular space-like surface of integration, as long as it lies in the same null hypersurface. Therefore, the integrals are related to the multipole structure of the charge distribution and the matter distribution, respectively. This relationship is shown explicitly for the electromagnetic field and for the linearized gravitational field. It follows that energy radiation as determined by the Einstein pseudotensor depends on the existence of a type III asymptotic behavior of the Riemann tensor. Finally, the asymptotic conditions are formulated under which the superpotential U_m^{as} will also lead to asymptotically invariant integrals. It is pointed out that the linearized gravitational field with retarded potentials satisfies these conditions as do the asymptotic solutions for the Einstein field equations $R_{ab} = 0$, which have been constructed by Bondi and Newman. The significance of this result for the interpretation of the Bondi metric is discussed. (auth)

31659 COMPLEX ANGULAR MOMENTUM IN PERTURBATION THEORY. R. F. Sawyer (Univ. of Wisconsin, Madison). Phys. Rev., 131: 1384-91(Aug. 1, 1963).

The leading singularity in the complex angular momentum plane is studied for certain sets of Feynman graphs. Two models are considered: (a) the ladder graphs in the $\lambda\varphi^4$ theory in which bubbles are exchanged, and (b) the ladder graphs for the scattering of two scalar mesons by vector meson exchange. The method used is the summation of the most singular term in every order of perturbation theory. In both models the leading singularity is a branch point on the real l axis to the right of $l = 0$. As the coupling constant is decreased, this branch point approaches $l = 0$. The nature of the branch point is very similar to that

of the branch point (near $l = -\frac{1}{2}$ for weak coupling) in the case of scattering from a potential with a r^{-2} singularity. (auth)

31660 DISCRETE MASS, ELEMENTARY LENGTH, AND A TOPOLOGICAL INVARIANT AS A CONSEQUENCE OF A RELATIVISTIC INVARIANT VARIATIONAL PRINCIPLE. U. Enz. Phys. Rev., 131: 1392-7(Aug. 1, 1963).

A nonlinear, Lorentz-invariant action principle is introduced. This variation principle, which deals with an "internal" angular variable θ, is obtained from analogy considerations of moving Bloch walls in magnetic crystals and of elementary particles. In the one-dimensional case the resulting Euler equations can be solved by elementary functions, describing, in the rest system, a spatially extended energy distribution. The total energy, and thus the mass, has a discrete character. An elementary length appears as a parameter of this energy distribution, i.e., as a parameter of the structure. The moving structure undergoes the appropriate Lorentz contraction. An invariant of topological nature comparable to the invariant of the Möbius strip is furthermore inherent in this structure. This invariant has the symmetry properties of the elementary charge. A solution of the three-dimensional case including an internal rotation seems possible. (auth)

31661 COMPLEX ANGULAR MOMENTUM IN SPINOR BETHE-SALPETER EQUATION. Arthur R. Swift and Benjamin W. Lee (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 131: 1857-69(Aug. 15, 1963).

A model of fermion-antifermion scattering, mediated by pseudoscalar neutral bosons, is described by the corresponding spinorial Bethe-Salpeter equation in the ladder approximation. The decomposition of the equation into partial waves by means of fusion amplitudes and conventional spherical harmonics is discussed in detail; various important symmetries of the resulting kernel and Born amplitudes are pointed out. The resulting set of coupled equations is continued into the complex angular momentum (J) plane, and it is shown that Fredholm theory is inapplicable for any J. The equations are solved in a weak coupling, low-energy limit by an iterative scheme. The resulting solutions exhibit a cut of the square-root type extending along the real axis to $G/2\pi$ (G = coupling constant) in the right-hand plane; other cuts and poles prevent the extension of our solutions into the left-hand J plane. The dominance of the cut is used to extract the large momentum transfer limit and obtain certain results for the high-energy limit in the cross channel. The total cross section for fermion-antifermion annihilation is extracted by means of the optical theorem and is found to exhibit an energy dependence of the form $t^{(G/2\pi)-1}[\ln t]^{-\frac{1}{2}}$, where t is the c.m. energy squared. (auth)

31662 DIVERGENCE AND SUMMABILITY OF THE MANY-FERMION PERTURBATION SERIES. George A. Baker, Jr. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 131: 1869-80(Aug. 15, 1963). (LADC-5726)

The convergence of the many-fermion perturbation series is studied, and it is shown for the case of the square-well potential that it is a divergent series. The rate of divergence is bound, and, by using appropriate summation procedures, it may be summed to the physically correct sum, provided the density is low enough. (auth)

31663 REGGE POLES AND COMPLEX SINGULARITIES. John M. Cornwall (California Inst. of Tech., Pasadena), Kalyana T. Mahanthappa, and Virendra Singh. Phys. Rev., 131: 1882-8(Aug. 15, 1963).

The analyticity in complex angular momentum for the case in which complex singularities are present in double-spectral representations of scattering amplitudes is studied. The simple example considered is $\Sigma\Sigma$ scattering. It is shown that Regge continuation exists and has the same qualitative characteristics as for the case of no complex singularities. In particular, no direct connection is found between the presence of complex singularities and the existence of the branch cuts in angular momentum. (auth)

31664 GRAVITATIONAL RADIATION AND ABERRATED CENTRIPETAL FORCE REACTIONS IN RELATIVITY THEORY. PART 2. RETARDED COHESIVE FORCES. James C. Keith (Univ. of Detroit). Rev. Mex. Fis., 12: 1-25(1963). (In English)

It is shown from the standpoint of relativistic gravitational theories that centripetal as well as gravitational aberrated force reactions can contribute to damping of a freely spinning system of accelerating masses. The result predicts that a "freely" spinning mass system will dissipate energy at a rate directly proportional to its kinetic energy and the factor $-KK'(a\omega/c)^3\ \omega\sec^{-1}$, ω being the angular velocity, a the maximum spin radius, c the velocity of light in vacuo, $K \sim 1$ a dimensionless ratio of the system's moments, and $K' = 2\gamma M/Rc^2 = 1$ for reaction of the accelerating system with the universe. For a small rotor magnetically suspended and spinning freely in ultra-high vacuum, the power loss can be detected by measuring the decay of the rotor's frequency. For $a = 10^{-2}$ cm and $f = \omega/2\pi = 5 \times 10^5$ cycle/sec the predicted decay would be on the order of $\frac{1}{6}$ cycle/sec each day. (auth)

31665 MÖSSBAUER EFFECT AND THE THEORY OF RELATIVITY. Ya. A. Smorodinskii. Usp. Fiz. Nauk, 79: 589-94(Apr. 1963). (In Russian)

The experiments of Pound and co-workers on the Mössbauer effect in Fe^{57} were examined to determine just what aspects of the general theory of relativity are checked by their results. The experiments were designed, in particular, to check one equation of the gravitational theory, i. e., the Schwarzchild central field equation. It was concluded that the experimental results have checked only the law of conservation of energy. In order for the described experiments to contribute information concerning the geometry of space it is necessary to measure at least the distance between the source and the detector. Thus one could measure the time that light has to travel between the source and detector and back again. It is also clear that the experiments involving earth satellites cannot give any more information than are obtained from laboratory investigations. This is because one must again have an exact method for the measuring of the time needed for the signal traversal. (TTT)

31666 INDUCED RADIATION PROCESSES IN QUANTUM AND CLASSICAL THEORIES. I. I. Sobel'man and I. V. Tyutin. Usp. Fiz. Nauk, 79: 595-616(Apr. 1963). (In Russian)

It is pointed out that induced radiation effects cannot be purely quantum in nature and that they must be present in the classical theory of radiation processes. The classical theory is usually built on the example of the harmonic oscillator. Several effects arising from the interaction of the oscillators with the field disappear when harmonic oscillators are considered. This is particularly true when one is concerned with radiation processes induced by the field. In addition, the interaction between the field and the radiation of nonlinear oscillators (their frequencies depend on the energy) was not previously considered from the standpoint of the classical theory. Because of these rea-

sons and because of the interest in the problem of quantum generators the question of the role of induced radiation in classical theory was examined. The theory is described, and some specific properties of the classical system are contrasted with those of the quantum system. The description includes a discussion of spontaneous radiation processes and both harmonic and anharmonic oscillators are considered. The limiting transition from quantum to classical theory is discussed, and a detailed comparison of the two theories is made. An ensemble of oscillators distributed in energy is discussed in the classical theory. It is shown, for certain determined conditions, that classical systems do not absorb but rather enhance incident radiation. (TTT)

31667 REPORT ON A UNIFORM FIELD THEORY. Willy Scherrer (Universität, Bern). Z. Physik, 174: 351-2 (1963). (In German)

Equations for a uniform linear field theory are given. (M.C.G.)

REACTOR TECHNOLOGY

General and Miscellaneous

Refer also to abstracts 30176 and 31080.

31668 (AAEC/TM-184) A TWO-GROUP END REFLECTED CYLINDRICAL REACTOR PROGRAMME FOR THE IBM 1620. N. Spinks (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Mar. 1963. 14p.

A program is given to calculate the critical size and the two-group flux distributions in a cylindrical reactor with identical top and bottom reflectors. The core is not reflected on the sides. In addition to the size and the flux distributions, the program output included the initial fuel investment together with parameters which will enable evaluation of the fission heat release distribution. The output of a parameter to enable the manual calculation of coolant outlet temperature from a gas cooled reactor is also available. The program may be used for reflector savings studies, for heat distribution calculations, or as a check program for more ambitious calculations. (auth)

31669 (AAEC/TM-191) INTEGRAL REACTION RATES AND NEUTRON ENERGY SPECTRA IN A WELL MODERATED REACTOR. J. W. Connolly, A. Rose, and T. Wall (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Apr. 1963. 36p.

Cadmium ratio measurements in the internal reflector of MOATA were made with gold, indium, tungsten, manganese, molybdenum, and copper detectors. These measurements were analyzed on the assumption that the neutron spectrum consists of a Maxwellian distribution to which is smoothly joined a 1/E slowing down spectrum, the cross sections being averaged according to the methods of Westcott. A search through recent literature suggests that the s factors for gold and indium listed by Westcott are in error. If this is accepted, then it appears that the measured epithermal spectrum is closely 1/E in form for neutron energies between 1 and 600 ev. The corrections to be applied when foils of finite thickness are used in cadmium ratio measurements are discussed, and the spectrum derived from these measurements was used to calculate reaction rate ratios of copper : indium and copper : gold alloy foils. These ratios were compared with measured values. Values of the effective resonance integral of Pt^{198} wire detectors were measured, and from these values an estimate was made of the infinitely dilute resonance integral of this isotope. (auth)

31670 (AE-104) PROBLEMS IN PRESSURE VESSEL DESIGN AND MANUFACTURE. O. Hellstroem (Uddeholms A. B. Degerfors Järnverk, Sweden) and Ragnar Nilson (Aktiebolaget Atomenergi, Stockholm). May 1963. 43p.

The general desire to increase power rating and efforts to involve more advanced thermal behavior and fuel handling facilities within the reactor vessels are accompanied by an increase in both pressure vessel dimensions and various difficulties in giving practical solutions of design, materials and fabrication problems. It can be postulated that with use of better materials and adjusted fabrication methods the size problems can be solved; it seems likely that vessels of sufficient large diameter and height for the largest power output, which is judged as interesting in the next ten year period, can be built without developing totally new site fabrication technique. It is, however, supposed that such a fabrication technique will be feasible though at higher specific costs for the same quality requirements as obtained in shop fabrication. By the postulated use of more efficient vessel material with principally the same features of easy fabrication in different stages such as preparation, welding, and heat treatment as ordinary or slightly modified carbon steels the increase in wall thickness might be kept low. There exists, however, development work to be done for low-alloy steels to prove their justified use in large reactor pressure vessels. (auth)

31671 (AEEW-R-233) THE VALIDITY OF METHUSELAH I IN REACTIVITY PREDICTIONS. F. R. Allen and D. Hicks (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Dec. 1962. 20p. (EACRP-U-3)

The METHUSELAH I lattice program was used to predict values of K_{eff} corresponding to the measured bucklings of a range of lattices moderated by light and heavy water. For 18 light water lattices the mean values of K_{eff} and the mean square deviation is 1.000 ± 0.007; while for 45 cluster fuelled D_2O moderated lattices the corresponding figures are 0.994 ± 0.006. It is concluded that METHUSELAH is suitable for use in survey calculations on both light and heavy water systems. However, further analysis and intercomparison with experimental reaction rates and more detailed theoretical calculation is required, both to improve the accuracy and to remove the possibility of spurious cancellation of errors. (auth)

31672 (AEEW-R-249) FEW GROUP NUCLEAR DESIGN METHODS FOR HEAVY WATER REACTORS. D. Hicks (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Jan. 1963. 52p. (EACRP-U-2)

A brief description is presented of a 5-group nuclear calculation scheme that was developed for survey and initial design calculations for heavy water lattices. This scheme is an extension of the 4-group methods developed at the Bettis Laboratory for light water lattices; two overlapping thermal groups are, however, used to represent the large variations of thermal neutron spectra that can occur in clustered lattices. The 5-group scheme forms the basis of a comprehensive computer program known as METHUSELAH, which can be used to investigate a variety of design problems such as lattice reactivity, burn-up, reactivity coefficients, cluster power peaking factors, etc. Typical results are presented and compared with experimental data or the results of more elaborate theoretical investigations. 51 references. (auth)

31673 (BMI-X-10051) A STUDY OF ROTARY SHAFT-SEALING CONCEPTS FOR PRESSURIZED-WATER REACTOR APPLICATION. Quarterly Progress Report, April–June 1963. C. Malcolm Allen and Daniel R. Grieser (Battelle Memorial Inst., Columbus, Ohio). July 1, 1963. Work performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 5p. (EURAEC-740)

The behavior of rotary face seals is being studied by means of an instrumented transparent model which allows direct observation of the fluid in the seal gap during operation. The seal apparatus was designed, constructed, and

commissioned. Initial operation has not disclosed any serious problems, although a revised water-circulating system which substitutes a double loop for the former single-loop system, is being installed. Instrumentation for determining the dynamic-seal gap width was evaluated and seems satisfactory for the purpose intended. The early experiments will be directed at studying the film-rupture phenomenon in the seal interface. A packed-gland seal facility was designed and constructed. The facility will be capable of handling both conventional and inverted packing-seal configurations. Instrumentation will include means for measurement of packing temperature and frictional torque and optical systems for direct observation of the packing rubbing interface. (auth)

31674 (CEA-2253) FORMULAIRE SUR LE CALCUL DE LA PROTECTION DES REACTEURS. (Handbook for the Calculation of Reactor Protection). (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). 1963. 253p.

A handbook for the calculation of reactor protection is presented. This handbook makes it possible to calculate the different neutron and gamma fluxes and consequently, to fix the minimum quantities of materials necessary under general safety conditions both for personnel and for installations. It contains nuclear data, calculation methods, and constants corresponding to the present state of knowledge. (auth)

31675 (CONF-14-6) LARGE-SCALE SEA WATER CONVERSION USING NUCLEAR ENERGY. R. Philip Hammond (Oak Ridge National Lab., Tenn.). [1963]. Contract [W-7405-eng-26]. 7p.

From American Chemical Society 144th National Meeting. Los Angeles, Calif., March–April 1963.

The economics of desalting processes for sea water using large nuclear reactors as a source of power for water distilling plants is discussed. It is pointed out that low-cost electric power could be obtained as a byproduct in such plants. It is suggested that a 3500 Mev pilot plant of the natural uranium type could be undertaken in a relatively short time and would produce water in the cost range under 20 cents/1000 gal and power for 3 mills/kwhr or less, after writing off development costs. It is also suggested that breeder reactors would ultimately produce the lowest cost energy, but would need a longer time for development. Cost estimates are presented using regenerative evaporation in multi-effect or flash type evaporators and natural uranium reactor or an advanced fast breeder reactor. The cost of water would be 9.8 cents/1000 gal or 6.1 cents/1000 gal, depending on the reactor type used. (C.H.)

31676 (DP-793) CONTAMINATION AND DECONTAMINATION OF LOW TEMPERATURE, WATER-COOLED REACTORS. PART III. DECONTAMINATION OF SPECIMENS OF REACTOR PIPING. A. B. Carlson (Du Pont de Nemours (E. I.) & Co. Savannah River Lab.). Mar. 1963. Contract AT(07-2)-1. 36p.

In laboratory decontamination tests, phosphoric acid effectively decontaminated specimens of AISI type 304 stainless steel from the coolant (moderator) and blanket gas systems of production reactors at the Savannah River Plant. Purification effluent piping and piping that contained stagnant coolant were more difficult to decontaminate than tubing and core rods from heat exchangers. The presence of alumina in the crud film probably causes decontamination to be more difficult than would be predicted for a film formed at the low temperature of the SRP reactors. (auth)

31677 (GEAP-3771-1) HIGH PERFORMANCE UO_2 PROGRAM. Quarterly Progress Report No. 1, April–June 1961. B. Weidenbaum (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). July 1, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 35p. (EURAEC-68)

The maximum operating characteristics that can be achieved with the use of UO_2 as a reactor fuel are being investigated. Fuel assemblies are being fabricated for measurement of fission gas pressure in UO_2-filled fuel rods. A pressurized-water loop in GETR is being designed. A heat transfer burnout study is in progress to establish the upper limit of heat flux for studies of central melting in a fuel rod and fuel-cladding interactions. (M.C.G.)

31678 (GEAP-3957) SODIUM-COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Second Quarterly Report, January–March 1962. F. J. Leitz, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Contract AT (04-3)-189. 161p.

Progress is reported on the development of the Experimental Fast Ceramic Reactor and Fast Ceramic Reactor and demonstrations of low fuel cycle cost capability for the reactors. Further design work was accomplished on a fast reactivity excursion device for the EFCR. Preliminary experiments were accomplished involving gas charging used for pneumatic activation. Modification of the conceptual design of the original EFCR facility and scoping of the EFCR for a broader experimental program than originally proposed is reported. Evaluation of the transport of fission products in previously irradiated Phase I specimens was accomplished. Transient testing of EFCR-type fuel rods is reported. A study comparing the economic potential of mixed carbide fuel with mixed oxide fuel for fast reactors was conducted. A study was made of the processes available for fabrication of plutonium-containing fuel for a fast ceramic reactor, and for chemical reprocessing of irradiated fuel. A 37 fuel pin FCR prototype assembly and a 19 (individually encapsulated) FCR fuel pin assembly were designed for prospective fast flux testing in the EBR-II reactor. A single fuel pin test capsule was designed for the Dounreay Fast Reactor. Refinement and debugging of the FORE digital computer code, designed to analyze the transient thermal-nuclear behavior of fast reactors, has proceeded to the point where the code is being run on a routine basis. The transient characteristics of a large fast ceramic reactor configuration were investigated using the FORE code. The preliminary design status of a 500 Mw(e) FCR power plant is summarized. The EICA (Elastic-Inelastic Cross Section Averaging) computer code is specified in sufficient detail to permit coding to start. The RAPTURE computer code designed for the computation of Doppler coefficients in fast reactors is described. Technical evaluation of a proposed series of FCR critical experiments to be carried out in the ZPR III facility was made. (N.W.R.)

31679 (GEAP-4158) SODIUM-COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Fifth Quarterly Report, October–December 1962. F. J. Leitz, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 1963. Contract AT(04-3)-189.

Progress is reported on the development of a reliable, high-performance fast reactor and demonstration of low fuel cycle cost capability for such a reactor, primarily through achieving high burnup of ceramic fuels operating

at high specific power. The first series of six sodium logging experiments were successfully completed utilizing UO_2 pins. Conceptual design of an in-pile capsule experiment to determine release of fission products from mixed oxide fuel into sodium coolant was completed. Preliminary design and cost estimation of in-pile sodium loops and loopsules were completed. Series I testing was completed. Estimated fuel cycle costs for two carbide reactor and fuel designs are compared with that previously estimated for a reference oxide design. Sintering developments for mixed oxides are reported. Several modifications of FCR core design and operating conditions are being evaluated on the basis of new cross section data and improved calculation methods, aiming at a best balance between safety parameters and fuel economics. (N.W.R.)

31680 (HW-75278) COMPARISON OF WESTCOTT SPECTRUM WITH THE GAS AND WATER KERNEL MODELS: DETERMINATION OF THE NEUTRON TEMPERATURE AND EPI-THERMAL INDEX. F. G. Dawson and L. H. Steves (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1962. Contract AT(45-1)-1350. 34p.

Comparisons were made of the Westcott flux and the flux distribution in the thermal and near thermal region determined by using the gas kernel and Nelkin's water kernel model. Flux distributions were determined for compositions of water and several absorbers including U^{235}, Pu^{239}, Pu^{240}, and boron. From these distributions, epi-thermal to thermal flux ratios and effective neutron temperatures as a function of absorption to slowing down power ratio were determined. The variation of the absorption cross sections with energy for the different absorbers was found to have a marked effect on these parameters. The epi-thermal to thermal flux ratios were compared with ones calculated using the Westcott model and were found to be in poor agreement for $\Sigma_a/\xi\Sigma_s > 0.1$. It was also found that the flux perturbations produced by the neutron absorptions in the Pu^{239} resonance at 0.3 ev can produce considerable errors in reaction rate calculations using the Westcott model. From this study, it is concluded that the assumption of a Maxwellian plus a 1/E tail has serious limitations and can yield particularly poor results for plutonium-fueled systems. (auth)

31681 (HW-76559) RESEARCH AND DEVELOPMENT PROGRAMS EXECUTED FOR THE DIVISION OF REACTOR DEVELOPMENT. Quarterly Progress Report, October–December 1962. M. M. Hendrickson and J. K. Green, eds. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1963. Contract AT(45-1)-1350. 118p.

Progress is reported on studies of basic properties of fuel materials and fabrication methods, physics, chemical processing of reactor fuels and radioactive waste, materials development, irradiation effects on materials, fuel cycle analysis and advanced concepts, instrumentation, and nondestructive testing techniques. The results of the studies are considered widely applicable to the Civilian Application Program. (B.O.G.)

31682 (IITRI-A6042-1) STUDIES OF REACTOR CONTAINMENT. Bimonthly Progress Report, April–May 1963. E. V. Gallagher (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Contract AT(11-1)-578. 35p.

Progress is reported on crushable shield analysis and design, shock impingement experiments on crushable solids, and coolant decompression experiments and analysis. A computer program is being prepared for stress wave motion in a one-dimensional single-layered media. A theoretical study of elastic wave propagation in layered materials was begun. Experiments were carried out in a water shock tube at initial operating temperatures in the range of 500 to 600°F. (M.C.G.)

31683 (JEN-115-DF/I-34) TAR-1. PROGRAMA PARA LA DETERMINACION DEL COMPORTAMIENTO TEMPORAL DE LA DENSIDAD NEUTRONICA EN REACTOR TERMICO. (TAR-1. A Program for the Determination of Time Behavior of Neutron Density on a Thermal Reactor). J. Torres Vida (Spain. Junta de Energía Nuclear, Madrid). 1963. 12p.

TAR-1, written for the UNIVAC-UCT of J.E.N., obtains the time behavior of neutron density as a function of both positive and negative step changes in reactivity. These results are obtained from solutions of the space-independent kinetic equations of a bare thermal reactor based on the Fermi continuous slowing down model and using six groups of delayed neutrons. (auth)

31684 (NAA-SR-Memo-8247) FISSION PRODUCT RETENTION IN REACTOR COOLANTS. RESULTS OF THE SECOND IN-PILE EXPERIMENT. W. P. Kunkel, D. M. Elliott, and A. S. Gibson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [Mar. 3, 1963]. Contract [AT(11-1)-Gen-8]. 41p.

The second in-pile experiment of the Fission Product Retention Project was completed. This experiment used the KEWB to melt a preirradiated enriched uranium sample in a 500°F sodium environment. Results of the experiment indicated that less than 0.002% of the I^{131} which was measured in the sodium was released to the helium cover gas. These results were obtained for a bulk sodium temperature of 500°F, preirradiated fuel disc, and essentially continuous cover gas flow during the burst and sodium refreezing period. During the transient, the energy release from the fuel was approximately 0.66 Btu. In contrast to the previous experiment, which used unirradiated fuel, only a small fraction of the I^{131} inventory was retained in the fuel. This result is tentative because of an incomplete activity balance. As a result of the second in-pile experiment, several modifications to the preirradiation technique and capsule design were made. (auth)

31685 (NAA-SR-Memo-8513) LONG TERM FISSION PRODUCT DECAY FORMULATION. C. R. Harder (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 20, 1963. Contract [AT(11-1)-Gen-8]. 14p.

An expression relating fission-product activity as a function of decay time after long periods of decay may be developed by considering the contributions of relatively few isotopes. Further simplifications may be made by grouping isotopes of similar half life and assuming constant contributions from those of extremely long half life. The resulting expression, after simple algebraic manipulation, appears as: $A = \xi\,[2.56 \times 10^{-7} + \exp(-2.4t)\{5.6 \times 10^{-3} + 3.8 \times 10^{-5} \exp(1.5t)\}]$, where A = gross fission product activity, t = decay time in hundreds of years, $\xi = 0.88\ P\ T_0$ curies, P = power level of operation in watts, and T_0 = duration of operation in years. Results generated by the formulation were compared to the output of the "Curie" code and found to be in very good agreement. The range of applicability is 10 years to 100,000 years with accuracy between ~ ±10% at the extremes. (auth)

31686 (NAA-SR-Memo-8581) NEUTRON KINETICS FOR REFLECTED COMPACT REACTORS ON SHORT PERIODS. Joseph Miller (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 3, 1963. Contract [AT(11-1)-Gen-8]. 9p.

The common seventh group approximation for treating the effect of neutron delay due to reflector slowing down and thermalization is presented. Modifications appropriate when reactivity changes are produced by reflector movements are introduced. An improved formulation, allowing distinctions between several different groups of slowing down and thermalizing neutrons, is presented. This formulation is shown to reduce to the seventh group approximation for the case of one atypical neutron group, providing the population and reaction rate of the group are small in comparison to the total neutron population and reaction rate. (auth)

31687 (NYO-10285) ULTRASONIC CLEANING. I. FILM REMOVAL FROM ORGANIC MODERATED FUEL ELEMENTS. William B. Tarpley and Richard Pheasant (Aeroprojects, Inc., West Chester, Penna.). June 1963. Contract AT(30-1)-3121. 58p.

The feasibility of removal, through specially designed ultrasonic hardware, of heat-transfer-limiting films which form on the surface of reactor fuel plates was investigated. The removal of a variety of film deposits simulating the range of coatings expected in the OMRE was carried out on coupon specimens. The most effective ultrasonic activation method was direct coupling to the specimen. The best liquid medium, dimethylacetamide, combined a high cavitation threshold with high solvent power for typical deposits, but Santowax OMP (a relative nonsolvent) could be used as a cleaning medium if the lower cleaning rate could be tolerated. Ultrasonic activation of a complete (dummy) fuel-element bundle was demonstrated, as well as activation of flat plates, ribbed plates, and helical-ribbed pins. These investigations indicated that in-reactor cleaning of fuel elements, for the purpose of extending their useful life, is feasible. Demonstration of the total process is recommended. (auth)

31688 (TID-18322) DEVELOPMENT OF EQUIPMENT AND INSTRUCTION MANUAL FOR NUCLEAR REACTOR SIMULATORS. Richard R. Stewart (Northeastern Univ., Boston). Feb. 1, 1963. Contract AT(30-1)-2938. 133p.

Experiments for a special-purpose reactor simulator are presented. The components and circuitry found in this type of simulator are discussed. Each experiment is presented in 5 parts: background, theory and equations, specific procedures, general procedures, and literature citations. The following experiments are included: control rod calibration, measurement of reactor period, temperature coefficient of reactivity, verification of the inhour equation, approach to criticality, the prompt critical condition, effect of poisons on reactor operation, determination of neutron cross sections by the danger coefficient method, and automatic power level control. General purpose analog computer solutions of the nuclear reactor kinetics equations are given. (M.C.G.)

31689 NUMERICAL DETERMINATION OF A SHIELDING INTEGRAL OF CYLINDRICAL FUEL RODS. E. Keberle (Argonne National Lab., Ill.). Atomkernenergie, 8: 204-7(June 1963). (In German)

Self-shielding integrals of two single fuel rods were tabulated for 4 different scattering media as a function of radius and center distance of the fuel rods. As the 3-fold integral opposes elementary integration, it was transformed into an integral whose integrand is the product of two other integrals. This reduction afforded a careful discussion of the transformed region of integration, and although it led to the introduction of a singularity in the integrand, the expression is for purposes of machine-integration, of the order of a double integral. (auth)

31690 INFLUENCE OF THE COOLING SYSTEM ON THE POWER LIMITS OF PRESSURIZED-LIQUID REACTORS. A. Mareske. Atomkernenergie, 8: 213-23 (June 1963). (In German)

The technical limits for the optimum design of a reactor are defined in diagrams by the maximum heat velocity of the fuel elements and by the indices of the cooling system (degree of cooling efficiency, reboil margin, and reactor index). The so-called "marginal capacity" of a reactor is determined by the power limits of a reactor given by the maximum thermal neutron flux in the fuel, the maximum fuel and surface temperature of the fuel elements, and by the consumption of the primary cooling system. When reactor plants are designed, and adaptation of the technical and nuclear physical calculation methods to one another is possible by means of the established diagrams, once the nuclear physical optimum design is determined by the infinite multiplication constant as a function of the volume ratio of moderator to fuel. The established indices of the cooling system can also be reciprocally used for the evaluation of pressure fluid reactor types. (auth)

31691 THE CRITICAL EQUATION OF REACTOR. I. THEORY. Satoshi Nagayama. Denki Shikensho Iho, 27: 52-72(Jan. 1963). (In Japanese)

A second-order differential equation is developed to describe the asymptotic space deperdent thermal neutron spectrum in a finite medium by using Wilkin's method in the thermal energy region, and the fast neutron spectrum is assumed to be of 1/E distribution. The differential equation is expanded by the space eigenfunction and the energy eigenfunction, and the critical equation of the energy-space dependence on the neutron spectrum was developed. The conclusion shows that solving the effective cross section is equal to solving this critical equation which is higher in accuracy and is easier in calculation than usual critical equations. The usefulness of this method is emphasized. (auth)

31692 PULSED NEUTRON EXPERIMENTS ON SUBCRITICAL HEAVY WATER NATURAL URANIUM LATTICES. H. Meister (Kernforschungszentrum Karlsruhe, Ger.). J. Nucl. Energy, Pt. A & B, 17: 97-114(June 1963). (In English)

Prompt neutron decay in several subcritical D_2O-moderated natural uranium lattices is investigated by the pulsed technique. Employing various detector positions inside the multiplying medium, a separation of flux harmonics is achieved by means of a Fourier transform. From the modal decay curves the prompt neutron decay constant α is found as a function of geometrical buckling B^2. In the lower buckling region, $B^2 < 25\ m^{-2}$, experimental α vs. B^2 curves agree with simple two-group calculations on the basis of lattice parameters determined in exponential experiments. Deviations for higher B^2 are shown to be produced by spectrum shifts towards lower neutron energies. In addition, the change of radial buckling $\Delta\mu^2$ caused by cadmium rods fully inserted into the lattice is determined. The results are in agreement with stationary experiments as well as two-group calculations. With single fuel rods withdrawn from the lattice, however, the corresponding radial buckling change $\Delta\mu^2$ turns out to be strongly dependent on the buckling of the axial flux distribution. (auth)

31693 FIRST-FLIGHT COLLISION PROBABILITY IN MODERATOR-CYLINDRICAL FUEL SYSTEM. Y. Fukai (Nippon Atomic Industry Group Co., Ltd., Tokyo). J. Nucl. Energy, Pt. A & B, 17: 115-20(June 1963). (In English)

Derivation of an exact expression for calculating the

first-flight collision probability in a regular lattice, which consists of cylindrical fuel rods and moderator, is presented. The expression is derived by extending the analysis of a lattice of black absorbers to ones of finite cross section, this analysis being carried out without the simplifying approximation of the equivalent unit cell method, by taking account of a closed trigonometrical formula for the optical neutron paths occurring in the lattice. The first-flight collision probability for a water-moderated rectangular lattice with a moderator to fuel volume ratio of 1:1 and a fuel-rod diameter of 0.366 in. is numerically calculated. The results are compared with those found by the equivalent cylindrical unit cell method and various other approximations. It is concluded that the error introduced by cylindricalizing lattice cells in collision probability calculations for such a closely packed lattice is appreciable. (auth)

31694 AN EXPERIMENTAL METHOD FOR DETERMINING THE EPITHERMAL NEUTRON SPECTRUM INSIDE A REACTOR. B. Fastrup (Univ. of Aarhus, Denmark). J. Nucl. Energy, Pt. A & B, 17: 143-4(June 1963). (In English)

A function r_1 is defined that represents the strength of an epithermal neutron spectrum in the resonance energy region of a resonance neutron detector. If a set of r_1 values is measured by several different resonance detectors, and if the resonance regions are narrow and evenly distributed over the region of interest, the shape of the spectrum can be calculated. Two methods for experimentally determining r_1 are described, viz. the Cd-ratio method and the reaction-rate method. (T.F.H.)

31695 INVESTIGATIONS OF URANIUM–PLUTONIUM CYCLES WITH SPECIAL REGARD TO H_2O-MODERATED REACTORS. [PART] I. P. Wenzel (VEB EPkA, Berlin). Kernenergie, 6: 193-202 (May 1963). (In German)

The stationary condition of reactors charged with natural or depleted uranium was investigated, for which the plutonium was separated from the irradiated fuel and the refined fuel was used again. The investigation followed a simple model of the U–Pu system, in which the essential effects appearing in reactor operation were considered. The optimum values for the moderator-fuel volume relation and the portion of the returned plutonium were ascertained, for which the multiplication factor was a maximum in the infinitely extended system. A homogeneous fission zone with complete return of the plutonium was investigated. A heterogeneous structure for the fission zone was also treated; it originates by fuel holders with different fuel compositions. The influence of a partial plutonium return on the equilibrium concentration of the plutonium isotope was also investigated. The high value for Pu^{242} could be strongly depressed, while the equilibrium concentrations for Pu^{239}, Pu^{240}, and Pu^{241} were only disturbed a little. There exists an optimal value for the portion of the restorable plutonium. The multiplication factor is then a few percent greater than for complete return. That allows the burnup to be improved to about 1000 Mwd/t. On the basis of this neutron-physics investigation it seemed possible to operate a H_2O-moderated pressured- or boiling-water reactor with natural uranium (oxide) and partly returned plutonium. The attainable burnup lies in the region of 5000 to 10,000 Mwd/t. The general qualitative results are also applicable to the Th–U cycle. (tr-auth)

31696 SPECIAL APPLICATIONS OF CONVENTIONAL ELECTRICAL EQUIPMENT FOR THE ATOMIC ENERGY INDUSTRY. K. K. Schwarz. L.S.E. Eng. Bull., 7: Nos. 1-2, 1-12(Mar. 1963).

A survey is presented of the applications of conventionally developed electrical equipment in the atomic energy industry. Both out-of-reactor and in-reactor equipment is considered, and the equipment described includes fan, pump, and compressor drives and reactor control drives and equipment. (D.L.C.)

31697 THEORY OF PULSED NEUTRON SOURCE MEASUREMENTS. Edward Garelis and John L. Russell, Jr. (General Electric Co., Pleasanton, Calif.). Nucl. Sci. Eng., 16: 263-70(July 1963).

A method of utilizing pulsed-neutron-source measurements for the determination of the subcriticality of an assembly directly in terms of dollars is proposed. Essentially, the method determines a certain parameter ($k\beta/l$) using the complete response curve of a repetitively pulsed assembly after the quasi-equilibrium state has been attained. This value of ($k\beta/l$) coupled with the α measurement, assuming the prompt decay constant to be dominant, yields the reactivity directly. The analytical model is based on a bare one-group diffusion theory system with m-delayed precursors. The application of these results to experiment shows that their applicability is much broader than the simple analytical model would indicate. (auth)

31698 APPROXIMATE ESCAPE PROBABILITIES. A. Sauer (Allgemeine Elektricitäts-Gesellschaft, Frankfurt am Main). Nucl. Sci. Eng., 16: 329-35(July 1963).

The rational approximation to the escape probability is generalized to contain a geometry-dependent parameter. In this way, approximate expressions that are both simple and accurate are obtained for the escape probability from solid and hollow fuel rods, and for the Dancoff correction in regular rod lattices. These approximations are derived from suitably chosen one-parametric chord distribution functions that have the same general character as the exact chord distributions of the fuel and moderator regions. It is shown that it is reasonable to determine the parameter belonging to each geometry—the geometric index—from the condition that the logarithmic moment of the exact and the approximate chord distribution functions be equal. The geometric indices are given for solid and hollow fuel rods, and for square and hexagonal lattice configurations. For solid or hollow fuel rods the error in the approximation is less than 1%. The Dancoff correction for rod lattices is obtained with comparable accuracy. (auth)

31699 XENON OSCILLATIONS IN FINITE REACTORS. R. M. Pearce (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 16: 336-7(July 1963).

The threshold conditions for Xe oscillations in bare parallelepipeds and cylinders are determined, starting from the threshold conditions for Xe oscillations in a one-dimensional slab reactor. The case of nonuniform composition in the parallelepiped is discussed. (T.F.H.)

31700 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. John Ewart Richards (to United Kingdom Atomic Energy Authority). British Patent 924,748. May 1, 1963. Filed Jan. 20, 1960.

The design of a Pu-fueled reactor, in which a prolonged burn up of the fuel may be obtained without fuel reprocessing, is patented. The fuel, a cermet of plutonium oxide and stainless-steel particles, may be in sheet form clad in stainless steel. The fuel sheets are arranged in a lattice pattern in a neutron-moderating material, with one face in close proximity with the moderator and the other face fluid-cooled. Alternative designs include a multiplicity of tubular clad fuel elements providing a liner for coolant passages through a graphite moderator, and blocks of

moderator material sheathed in clad fuel and spaced apart for coolant passages. The core design minimizes the possibility of a serious release of fission products due to failure of the cooling and control systems. (M.P.G.)

31701 IMPROVEMENTS IN OR RELATING TO ACTINIDE METAL OXIDE SOLS. Thomas Lee O'Connor, Walter Juda, Paul Henry McNally, and Norman Wolfson Rosenberg (to Diamond Alkali Co.). British Patent 924,999. May 1, 1963. Priority date June 19, 1958, United States.

Specific aqueous hydrated actinide metal oxide sols and methods of preparing the sols are patented. The sols are of controlled and substantially uniform particle size and preferably near-neutral pH and have a controlled concentration of one or more of the oxides of the elements Th, U, and Pu. The sols are suitable for use as fuels in single-region and 2-region homogeneous reactors. (M.P.G.)

31702 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS AND THEIR OPERATION USING ACTINIDE METAL OXIDE SOLS AS FUELS. Thomas Lee O'Connor, Walter Juda, Paul Henry McNally, and Norman Wolfson Rosenberg (to Diamond Alkali Co.). British Patent 925,000. May 1, 1963. Priority date June 19, 1958, United States.

A noncorroding homogeneous reactor using actinide metal oxide sols as fuels is patented. The reactor core is a metal container enclosing the sol, and a means for circulating the sol through it is provided. Since actinide metal oxide sols are comparatively noncorrosive, the reactor and its piping may be made of materials such as ordinary steel or galvanized iron, which would be corroded by fuels such as acid uranyl sulfate and abraded by slurries of oxidic actinide compounds. The use of sols provides inherent self-control, since they can expand, forcing excess volume into an expansion chamber. (M.P.G.)

31703 IMPROVEMENTS IN OR RELATING TO FLUID-TIGHT LIFTING ELECTROMAGNETS. Pierre Janot and Jacky Weill (to Commissariat a l'Energie Atomique). British Patent 925,122. May 1, 1963. Priority date Sept. 22, 1959, France.

A fluid-tight electromagnet designed for handling control rods in submerged nuclear reactors is patented. The core and winding are in a fluid-tight casing and are movable relative to the casing between one position, when power is supplied to the winding and the magnetic circuit is completed through the wall of the casing and the end of the piece being lifted, and a second position, to which the core and winding are returned by a spring when the power to the winding is cut off. An engagement-indicator device consisting of a microswitch actuated by a rod fastened to the core is also inside the casing. (M.P.G.)

31704 IMPROVEMENTS IN OR RELATING TO SPACING ARRANGEMENTS FOR NUCLEAR FUEL ELEMENTS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 925,154. May 1, 1963. Priority date May 22, 1959, Germany.

A method of spacing fuel rods arranged in parallel to form a reactor fuel element is patented. The spacing is accomplished by distance rings pushed on to the casing of the fuel rods. Parts of the ring contact the casing, and the rest of the ring is separated from the casing. Outside parts of the ring maintain the spaces between the rods. Various configurations for the distance rings are described. (M.P.G.)

31705 IMPROVEMENTS RELATING TO FLUX SCANNING EQUIPMENT FOR NUCLEAR REACTORS. Donald Francis Binns and Max William Jervis (to A.E.I.–John Thompson Nuclear Energy Co. Ltd.). British Patent 925,702. May 8, 1963. Filed May 30, 1958.

The design of an apparatus for measuring the radiation from a wire after it has been withdrawn from the core of a reactor is patented. The radiation from successive lengths of the wire is measured to determine the distribution of the neutron flux density within the reactor core. The response of a radiation detector to the radiation from the wire is indicated on an electrical indicating device. To compensate for the nonuniformity of the exposure time of the wire due to its insertion into and withdrawal from the core, a means for modifying the measurements is provided. An integral of the electrical output from the radiation detector or an integral of the input to the indicating device is subtracted from the input to the indicating device. The integral may be obtained from an electronic integrating network or from an instrument such as a watt-hour meter. (M.P.G.)

31706 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Alexander Gilchrist Frame and John Webb (to United Kingdom Atomic Energy Authority). British Patent 926,152. May 15, 1963. Filed Nov. 28, 1960.

A reactor design, primarily applicable to fast heterogeneous reactors in which the reactor can be shut down by removing part of the core, is patented. The removable part is independently supported in the core by a support capable of moving the part between an active position and a displaced position. Variations in the design include a reactor core consisting of 2 or more parts, all of which are movable, and a reactor core consisting of 2 parts, both of which can be moved to the same displaced position, so that only 1 fuel charging and discharging station is required. Various methods of displacing the core parts are described. (M.P.G.)

31707 IMPROVEMENTS IN OR RELATING TO FIRE-DETECTION APPARATUS. Denys Victor Booker (to United Kingdom Atomic Energy Authority). British Patent 926,605. May 22, 1963. Filed Mar. 24, 1961.

A device to detect fires in gas-cooled nuclear reactors is patented. The coolant gas leaving the reactor is monitored by two pairs of electrodes between which the gas passes. One pair of electrodes has an electric field sufficiently high to collect the large ions emitted by burning materials and the small ions produced by the induced radioactivity of the coolant gas. The other pair of electrodes has a lower electric field and can collect only the small ions. The currents from the 2 pairs of electrodes are subtracted to give a current, which depends only on the number of large ions in the gas. Various configurations of the electrodes are discussed. (M.P.G.)

31708 IMPROVEMENTS IN OR RELATING TO SERVICING MACHINES FOR NUCLEAR REACTORS. Terence Edward Gouvenot Gardner and Robert Garbutt (to Bristol Aerojet Ltd.). British Patent 927,359. May 29, 1963. Filed Sept. 16, 1959.

A servicing machine for loading and unloading reactor fuel elements is patented. The reactor has a pressurized reaction vessel provided with a number of standpipes through which fuel elements and auxiliary equipment may be passed. The servicing machine consists of a connection leading from a pressure vessel and a tubular conduit structure in fluid-tight connection with, and universally jointed to, the connection. The conduit can be extended or contracted, and the end remote from the pressure vessel is adapted to engage and seal with a standpipe on the reactor. Means for moving the servicing machine along the face of

the reactor, extending and contracting the conduit, and sealing the conduit to the reactor standpipe are described in detail. (M.P.G.)

31709 AN IMPROVED NUCLEAR REACTOR. (to RNB Corp.). British Patent 927,539. May 29, 1963. Priority date Aug. 31, 1959, United States.

A heterogeneous light-water-and-graphite-moderated reactor, which is undermoderated with respect to graphite, is patented. The graphite moderator is traversed by passages containing light water as coolant and moderator. The coolant is introduced into each passage in the form of a spray or film on the walls of the passage. Criticality cannot be reached until the reactor moderation is completed by the injection of a sufficient amount of water into the passages. A burst of power in the reactor will increase the fuel/moderator ratio by evaporating the water film, thereby reducing the reactivity. Therefore, the effective multiplication factor of the reactor can be maintained within predetermined limits by controlling the rate of supply of light-water coolant. The operating temperature of the reactor is such that Pu fissions in preference to U and is prevented from accumulating in the reactor. (M.P.G.)

31710 HETEROGENEOUS NUCLEAR REACTOR. Bernard Bailly Du Bois (to Commissariat a l'Energie Atomique). British Patent 930,058. July 3, 1963. Priority date May 17, 1961, France.

The neutron flux distribution in a reactor can be improved by disposing the fuel elements in moderator material in a lattice consisting of a number of sub-lattice assemblies, each comprising fuel elements located in parallel channels. The channels in different sub-lattice would have different angular positions. (D.C.W.)

31711 IMPROVEMENTS RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Graham Coates (to A.E.I.-John Thompson Nuclear Co. Ltd.). British Patent 930,070. July 3, 1963. Filed Mar. 11, 1959.

A fuel element assembly providing sufficient cross section while maintaining good heat exchange efficiency consists of fuel rods supported in a conical array about a central pillar from which they are suspended. In fuel channels, the tops of the lower elements fit into the bases of the upper elements; and the pillars of the lower elements support the upper elements. (D.C.W.)

31712 A FAST NEUTRON PASTE-FUELED REACTOR. (to North American Aviation, Inc.). British Patent 930,600. July 3, 1963. Priority date May 9, 1961, United States.

High specific power and burnup capability can be realized in fast breeder reactors without the usual problems of fuel distortion and swelling by using a reactor core with several fuel-containing members in which the fuel is deposited in paste form. The fuel (UC, PuC, or ThC) in paste form can be confined in fuel containers or can be moved through the core, thereby removing fission gases and products from the active part of the core. A liquid metal system carries heat from the core. (D.C.W.)

31713 IMPROVED ELECTRON EMITTER. (to General Dynamics Corp.). British Patent 930,624. July 3, 1963. Priority date Nov. 15, 1960, United States.

Corrosion of carbon-containing electron emitters of nuclear thermionic cells by cesium attack can be inhibited by forming the emitter of a carbon-containing nuclear fuel body (carbide). The atom-to-atom ratio of the carbon to the fuel in the fuel carbide (UC) does not exceed 1.8:1. A refractory metal carbide (ZrC) may be mixed with the nuclear fuel carbide, but the atom-to-atom ratio of carbon and fuel in the nuclear fuel carbide must not exceed 1.4:1. (D.C.W.)

31714 NUCLEAR REACTOR FUEL ELEMENT CHANNELS. Andre Huet. British Patent 930,638. July 3, 1963. Priority date Dec. 15, 1958, France.

A uniform heat exchange ratio between a fuel element and the cooling fluid circulating in its channel can be obtained by designing the channel with restricted portions over a high temperature part of the element and with dilated portions over a cooler part of the element. The restricted and dilated regions would increase and decrease fluid flow respectively, thereby giving more uniform heat transfer. Transverse corrugations or conically convergent and divergent portions in fuel channels can be used. (D.C.W.)

31715 METHOD OF MANUFACTURE OF METAL ENCASED CORE MATERIAL. Ernest J. Peters (to U. S. Atomic Energy Commission). U. S. Patent 3,091,847. June 4, 1963.

A method of making reactor fuel elements in which the fissionable material is encased and sealed in steel or aluminum cladding having an enclosed channel from the fissionable material to the surface of the cladding at one end is described. Heat and pressure sufficient to bond the assembled fuel element are applied in a nonoxidizing atmosphere. (AEC)

31716 NUCLEAR REACTOR FUEL ELEMENTS AND METHOD OF PREPARATION. W. E. Kingston, B. Kopelman, and H. H. Hausner (to U. S. Atomic Energy Commission). U. S. Patent 3,096,263. July 2, 1963.

A fuel element consisting of uranium nitride and uranium carbide in the form of discrete particles in a solid coherent matrix of a metal such as steel, beryllium, uranium, or zirconium and clad with a metal such as steel, aluminum, zirconium, or beryllium is described. The element is made by mixing powdered uranium nitride and uranium carbide with powdered matrix metal, then compacting and sintering the mixture. (AEC)

31717 STEAM GENERATOR FOR NUCLEAR REACTOR. B. W. Kinyon and G. D. Whitman (to U. S. Atomic Energy Commission). U. S. Patent 3,097,630. July 16, 1963.

The steam generator described for use in reactor power-generating systems employs a series of concentric tubes providing annular passage of steam and water and includes a unique arrangement for separating the steam from the water. (AEC)

31718 NUCLEAR REACTOR CONTAINMENT SYSTEM. Donald C. Schluderberg (to Babcock & Wilcox Co.). U. S. Patent 3,098,023. July 16, 1963. Filed Sept. 15, 1958.

A fluid-tight pressure shell is designed for completely enclosing the components of a reactor primary cooling system. The shell has a configuration generally conforming to the shape of the enclosed components and forming therein a narrow annular flow space. Means are provided for circulating a fluid through the flow space and for monitoring the fluid to detect leaks in the components. The flow space is divided into individual compartments for locating the leaks. The shell is also designed for rapid remote replacement of any enclosed component. (D.L.C.)

31719 COMPOSITE FUEL ELEMENTS FOR NUCLEAR REACTORS. Greenlief H. Barney and Lawrence C. Burman (to Engelhard Industries, Inc.). U. S. Patent 3,098,024. July 16, 1963. Filed Jan. 27, 1959.

A composite fuel rod is designed for efficient heat transfer from the fuel portion to the cladding portion. The rod comprises a core of depleted or natural uranium in the

form of UO_2 pellets or rods with Na or Pb as filler material, a lining of enriched U metal or alloy, and an outer corrosion-resistant layer. The outer layer and lining are bonded together to form a laminated tube. A major part of the heat energy generated in the nuclear reaction is generated in the lining. (D.L.C.)

31720 APPARATUS FOR CONTROL OF A BOILING REACTOR RESPONSIVE TO STEAM DEMAND. Michael Treshow (to U. S. Atomic Energy Commission). U. S. Patent 3,098,812. July 23, 1963.

A method of controlling a fuel-rod-in-tube-type boiling-water reactor having nozzles at the point of water entry into the tube is described. Water is pumped into the nozzles by an auxiliary pump operated by steam from an interstage position of the associated turbine, so that the pumping speed is responsive to turbine demand. (AEC)

Power Reactors

Refer also to abstracts 30918 and 31778.

31721 (ANL-6605) DESCRIPTION AND PROPOSED OPERATION OF THE FUEL CYCLE FACILITY FOR THE SECOND EXPERIMENTAL BREEDER REACTOR (EBR-II). J. C. Hesson, M. J. Feldman, and L. Burris (Argonne National Lab., Ill.). Apr. 1963. Contract W-31-109-eng-38. 194p.

The Fuel Cycle Facility for the Second Experimental Breeder Reactor (EBR-II), the process equipment, and the operations to be conducted in the facility are described. The Fuel Cycle Facility is a plant for reprocessing, by pyrometallurgical methods, the core and blanket material discharged from EBR-II. The reactor core alloy is uranium-5% fissium and contains about 46 wt. % U^{235}. The blanket material consists of U^{238} in which plutonium is bred. Core and blanket subassemblies contained in transfer coffins are transferred between EBR-II and the Fuel Cycle Facility, which is in an adjacent building. The Fuel Cycle Facility consists primarily of an argon-atmosphere cell where fuel processing is done, an adjacent air-atmosphere cell where reactor subassemblies are assembled and disassembled, and an operating area (for personnel) which surrounds the two cells. Because of the high levels of activity expected, the fuel-handling-and-processing equipment is designed for remote operation. Remote processing is accomplished with the aid of bridge cranes, electromagnetic bridge manipulators, and master-slave manipulators. Transfer ports and air locks are used in the transfer of materials and equipment into the air-atmosphere cell and between the two cells. The walls between the argon-atmosphere and air-atmosphere cells and the operating area are heavily shielded, and viewing is done through thick shielding windows. Operations may be described in general terms as including disassembly of reactor subassemblies and their constituent fuel elements, fuel purification, refabrication of fuel elements, and reassembly of the reactor core subassemblies for reloading into the reactor. Specific operations are: fuel transfer, sodium removal from the fuel subassembly, fuel-element decanning, chopping of fuel pins, melt refining, oxidation of skull material retained in melt refining crucibles, injection casting of fuel pins, final pin fabrication, canning of fuel pins, detection of leaks in canned fuel pins, sodium bonding and bond testing, fuel-element inspection, and assembly into fuel subassemblies. Topics covered are: auxiliary and alternative EBR-II fuel-cycle processes including skull reclamation, blanket, and other liquid metal processes; the physical metallurgy of uranium-fissium alloys; fuel movement and storage; sampling and analysis of fuel and waste; preparation, handling, and storage of feed materials for the processes; and preparation, handling and storage of liquid, solid, and gaseous radioactive wastes. Special problems of criticality, accountability, radiation shielding, disposal of scrap fuel and unrecoverable fuel, and nitridation of fuel are also discussed. (auth)

31722 (CONF-51-4) A 200 MWE PROTOTYPE SODIUM COOLED REACTOR HIGH EFFICIENCY POWER PLANT. J. A. Falcon and P. R. Keep (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [1963]. Contract [AT(11-1)-Gen-8]. 40p.

From American Public Power Association Annual Convention, Cleveland, Apr.-May 1963.

The SGR is shown to be a leading contender for a high-efficiency, economically attractive, inherently safe nuclear power plant. The plant discussed is a 200-Mw(e) single-loop prototype using uranium carbide fuel. Operating conditions are 2400 psig/1000°F, and the design net station heat rate is 8100 Btu/kwh. Fuel cycle costs are expected to be 21.5¢/10^6 Btu, or 1.74 mills/Nkwh. In areas with fossil fuel costs in excess of 25¢/10^6 Btu, the SGR is shown to be better-than-competitive for all normal system operating conditions. The SGR prototype can be scheduled for full-power operation in the latter part of 1968. The SGR offers the flexibility of interconnection with an existing boiler-turbine combination. Plant design is described. (auth)

31723 (DLCS-3410114) EXTERNAL RADIATION LEVELS OF REACTOR COOLANT LOOP PIPING AND PURIFICATION DEMINERALIZERS. (Duquesne Light Co., Shippingport, Penna.). Apr. 16, 1963. Contract AT(11-1)-292. 98p.

In order to determine the buildup of radiation levels near the reactor coolant loop piping and components and inside the purification system demineralizer concrete cubicle, periodic radiation surveys of selected points on these components were made using portable radiation detection equipment. The high radiation levels discovered during the first Seed 3 performance of this test were considered to be the result of crud which was dislodged from core components during Seed 2–Seed 3 refueling and deposited in the reactor coolant piping. The location of this crud was apparently affected by changes in the status of the plant during power operation and shutdowns. The radiation levels in the vicinity of the purification demineralizers generally increased with increased resin service hours, but these radiation levels could not be correlated with the radiation levels of the reactor coolant loop piping and components. The Jordan meters used during the surveys had undesirable characteristics which caused them to yield unreliable data. During Seed 2 and Seed 3 operations, there was an increase in the cobalt inventory in the reactor coolant. (auth)

31724 (DLCS-3410117) EXTERNAL RADIATION LEVELS OF REACTOR COOLANT LOOP PIPING AND PURIFICATION DEMINERALIZERS. CORE 1, SEED 3. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, Mar. 29, 1963. Contract AT(11-1)-292. 85p.

In order to determine the buildup of radiation levels near the reactor coolant loop piping and components and inside the purification system demineralizer concrete cubicles, periodic radiation surveys of selected points on these components were performed using portable radiation detection equipment. The data obtained during the tests indicated that the radiation levels of the reactor coolant loops in-

creased with accumulation of effective full power hours during Seed 3 operation. An increase was also observed during Seed 3–Seed 4 refueling and was attributed to crud being dislodged as a result of the reactor plant cooldown and/or the refueling operation, and subsequently being distributed through the system by core removal cooling flow and then normal reactor coolant circulation. The U-tube type heat exchangers exhibited higher average radiation levels than the straight tube type heat exchangers. Radiation levels in the vicinity of the purification system demineralizers generally continued to increase with resin service hours. (auth)

31725 (DP-830) AN EVALUATION OF HEAVY-WATER-MODERATED POWER REACTORS. Status Report as of March 1963. D. F. Babcock, R. R. Hood, L. Isakoff, J. C. Jensen, D. S. St. John, and J. W. Wade (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). June 1963. Contract AT(07-2)-1. 124p.

Heavy-water-moderated reactors are attractive candidates for vigorous development and commercialization in the U. S. nuclear power program. By virtue of their excellent neutron economy and their ability to operate on simple, massive, low-cost fuel elements, these reactors offer the potential of energy generation costs that are lower than those attainable in other converter reactors, higher conversion ratios than any other converter reactor, a self-sustaining breeding cycle with Th fuel, and low-cost steam for process heat applications such as desalination. It is concluded from consideration of estimated energy generation costs, neutron economy, present status of technology, and the extent of available development facilities that liquid D_2O and an organic liquid are the best candidates for further development as coolants for D_2O-moderated reactors. (auth)

31726 (GA-3053) EXPERIMENTAL BERYLLIUM OXIDE REACTOR PROGRAM. Quarterly Progress Report for the Period, January 1 through March 31, 1962. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Apr. 25, 1962. Contract AT(04-3)-187. 96p.

Progress made in the development of the Experimental Beryllium Oxide Reactor (EBOR) is reported. The objective of the EBOR program is to develop a gas-cooled, beryllium oxide-moderated reactor which can be used in conjunction with a closed-cycle gas turbine or a steam cycle for a small land-based or a maritime power plant. Progress is reported on reactor development, reactor physics, and materials development. (N.W.R.)

31727 (GA-4002) GRAPHITE–MATRIX NUCLEAR FUEL SYSTEMS FOR THE PEACH BOTTOM HTGR. D. V. Ragone, W. V. Goeddel, and L. R. Zumwalt (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Feb. 20, 1963. Contract AT(04-3)-314. 128p.

A summary of the development and evaluation of pyrolytic-carbon-coated carbide fuel particles and graphite–matrix fuel compacts is presented. A process that was developed for the preparation of particles of thorium–uranium dicarbide is described. Granulated particles composed of powdered UO_2, ThO_2, and carbon were suspended in a bed of graphite flour and heated to convert the oxides to dicarbides. The particles were then melted to densify and spheroidize them, while the graphite flour kept them separated so they would not flow together. Coating the (Th,U)C_2 particles with pyrolytic carbon was accomplished in a fluidized-bed apparatus using a methane–helium mixture at a temperature of ~1400°C. Data are presented on the properties of coatings. Graphite–matrix fuel compacts of high density were prepared by a hot-pressing process. Graphite flour was used as the filler and pitch as the binder; the use of graphite flour, rather than coke, permitted the attainment of good thermal properties in the compacts without the necessity for high processing temperatures. The hot-pressing process is described and the properties of the compacts are given. The thermal stability of coated fuel particles was evaluated at temperatures to 2000°C and for times up to one year. Some coated particles were found to fail in thermal gradient tests because of the movement of the particle through the coating on the high-temperature side; this was named the "amoeba effect." Tests of coated particles prepared by the techniques described showed that there should be no thermal instability at temperatures up to 1500°C for periods of at least three years. Results of extensive irradiation tests of graphite–matrix fuel compacts prepared by the hot-pressing process are presented. The compacts containing uncoated (Th,U)C_2 particles were dimensionally stable after burnups of 6.9×10^{19} fissions/cm^3 at 1100 to 1500°C. Compacts containing coated particles were tested to burnups of 1.2×10^{20} fissions/cm^3 at temperatures as high as 2000°C. A few per cent of the particle coatings were found to be broken after these tests. Possible explanations for these failures are presented. (Th,U)C_2 fuel particles coated with pyrolytic carbon had good xenon retention at first, but degradation occurred as high fuel burnup was achieved. Barium was found to permeate pyrolytic-carbon coatings which were impermeable to xenon, particularly at temperatures above 1400°C. Retention of iodine and tellurium by carbon coatings, although not quite as good as xenon retention, was much better than iodine and tellurium retention by uncoated (Th,U)C_2 particles. In postirradiation annealing runs, the rate of release of Xe^{133} from coated and uncoated (Th,U)C_2 fuels was measured at 1000 to 1700°C. The release of Ba^{140}, Te^{132}, and I^{131} was also determined for lightly irradiated samples. Xe^{133} release was interpreted in terms of the "equivalent spheres" approach. Release rates for short-half-life xenon predicted by this treatment were in approximate agreement with steady-state Xe^{138} and Xe^{139} release rates obtained out-of-pile for uncoated (Th,U)C_2 particles by using an electron linear accelerator to produce a steady rate of photo fissions. Data for Kr^{85m}, Kr^{87}, Kr^{88}, and Kr^{89} were also obtained in these out-of-pile experiments. In-pile experiments on samples of coated particles were performed to determine the effects of high fuel burnup and temperature on the retention of krypton and xenon fission-product nuclides. Activation energies for release were found to be about 29 kcal/mole for krypton and 39 kcal/mole for xenon. The results of these studies show that hot-pressed graphite–matrix fuel compacts containing pyrolytic-carbon-coated (Th,U)C_2 fuel particles will perform satisfactorily at the conditions to be encountered in the Peach Bottom HTGR (maximum temperature less than 1500°C in a purged fuel element). (auth)

31728 (GAMD-2100(Rev.)) THE 40 MW HTGR CONTROL ROD DRIVE. A. Harris and E. Ledin (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Mar. 1963. Contract AT(04-3)-314. 50p.

A description of the HTGR control rod drive is presented along with discussions of malfunction effects and the research and development effort devoted to the drive. The philosophy of the drive design is also discussed. (J.R.D.)

31729 (GEAP-4272) NUCLEAR SUPERHEAT PROJECT. INTERNAL STEAM SEPARATION DEVELOPMENT OF RADIAL VANE STEAM SEPARATORS. R. H. Moen (General Electric Co. Atomic Power Equipment Dept.,

San Jose, Calif.). May 31, 1963. Contract AT(04-3)-189. 115p.

The development, design, operation, and performance of a full-circle, radial-vane steam separator for the boiling water section of a nuclear superheat reactor are described. Steam–water tests of this model have demonstrated that it has a vane capacity in excess of that required for the 300-Mw(e) separate superheat reactor and for the 300-Mw mixed spectrum superheat reactor. It is proposed that the vane capacity requirement of the 600 Mw(e) separate superheat reactor may be attained by increasing the nozzle length. (N.W.R.)

31730 (NAA-SR-8468) STATISTICAL TREATMENT OF HOT CHANNEL FACTORS FOR COMPACT REACTORS. P. D. Cohn and H. A. Evans (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1963. Contract AT(11-1)-Gen-8. 39p.

The theoretical development, statistical treatment, and application of hot channel factors in compact SNAP reactors as represented by the SNAP 8 experimental core loading are presented. The channel and rod power effects of variation in the concentrations of uranium, hydrogen, and poison in the fuel rods are given. The statistical distributions of all variables are examined. A random selection of rods and channels is compared to the actual SNAP 8 configuration, with no difference noted. Confidence limits are set on hot rod and hot channel factors. Various other factors and aspects of the problem are discussed. The results of the study showed that the hot channel factors may be reduced to less than +2% over the nominal power, as opposed to a hot channel factor of about +10% as previously determined by empirical methods. (auth)

31731 (NAA-SR-Memo-2908) GAMMA-RAY DOSE AND HEAT GENERATION RATES ABOVE THE HNPF REFERENCE CORE DESIGN. W. P. Schiffries (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 1, 1958. Contract [AT(11-1)-Gen-8]. 24p.

Gamma-ray dose and heat generation rates through the Hallam Power Reactor loading face shield for the reference design core operating at 254 Mw are measured. The top shield is considered imperforate for this analysis, and no account is taken of neutron and gamma-ray streaming between gaps around plugs, through steel casings, and through control and safety rod penetrations. The results indicate a gamma-ray dose rate at the lower steel surface of the loading face shield of 6×10^5 r/hr and a heat generation rate of 1.3×10^{-3} w/g. At the upper surface of the 5-ft thick iron-limonite concrete shield, the heat generation rate is negligible, and the dose rate is only 7×10^{-3} mr/hr, corresponding to slightly less than 0.001 maximum permissible level. Due to inaccuracies in the method and data used and uncertainties in the assumptions, it is estimated that the results should be accurate to within a factor of four. (N.W.R.)

31732 (PWAC-370(Suppl.1)) PRELIMINARY SAFETY ANALYSIS REPORT FOR THE LITHIUM COOLED REACTOR EXPERIMENT (LCRE). C. C. Bigelow, P. Cole, D. T. Hedden, W. J. Fader, E. V. Sandin, et al. (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Sept. 29, 1962. Contract AT(30-1)-2789. 45p.

Modifications to the reactor test facility are described, and a maximum accident in which pipes break permitting coolant loss with resultant core meltdown is analyzed. A burst-energy release of 1.5×10^6 Btu is considered. A pressure-temperature time history is calculated, taking into account fission product decay heat, chemical reaction heat, and sensible heat of experiment components. The dose rate at the outer surface of the cell was estimated to be 2.2 r/hr immediately after, and 17 mr/hr 17 min after, the excursion. The highest offsite dose from fission product release is estimated to be about 6 rem. The results indicate that even a maximum accident in the facility would result in an acceptably small risk to the public. (D.C.W.)

31733 (SRO-84) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, JUNE 1963. (Savannah River Operations Office, AEC). 9p.

Progress is reported on various reactor development programs. Topics included are: Candu Reactor development on on-power refueling machine, boiler testing, fuel assembly testing, and radioactivity monitoring system; creep-rupture testing of SAP alloys, nondestructive testing of fuel cladding; header and feeder piping fluid dynamics; zirconium technology; heat transfer at low heat flux; capacity of heavy water reactors; hydraulic ball control system; material development; HWCTR operation; and Carolinas-Virginia Tube Reactor development and operation. (N.W.R.)

31734 (TID-3556(Rev.2) SELECTED REACTORS OF THE POWER REACTOR DEMONSTRATION PROGRAM. A Literature Search. James M. Jacobs, comp. (Division of Technical Information Extension, AEC). Jan. 1963. 124p.

Included are 927 of the reports dealing with 11 reactors of the Power Demonstration Program. Those included are the Big Rock Point, Elk River, Enrico Fermi, Florida, Hallam, Parr Shoals, Pathfinder, Peach Bottom, Piqua, Puerto Rico, and Yankee power reactors. Plans to build the Florida Power Reactor have been cancelled. The references are grouped by the reactor to which they pertain; the reactors are arranged alphabetically as above. Within each grouping, the reports are arranged alpha-numerically under the issuing agency. Availability for the reports is given in the report number index. Published literature citations are provided for those reports known to be published. (N.W.R.)

31735 (TID-7025(Suppl.1)) GUIDE TO NUCLEAR POWER COST EVALUATION. SUPPLEMENT NO. 1. (Kaiser Engineers. Div. of Henry J. Kaiser Co., Oakland, Calif.). Sept. 30, 1962. Contract AT(04-3)-334. 316p.

A guide is presented for use as a multi-purpose tool in the preparation and comparative evaluation of nuclear power plant cost estimates. It can also be used in analyzing and comparing estimated costs of various plant types and for assuring uniform classification of cost accounts. The supplement includes new and revised pages for Vols. 1, 4, and 5 of the first edition and should be used in conjunction with the original publications. (J.R.D.)

31736 (TID-19026) ELK RIVER REACTOR PRESSURE VESSEL INVESTIGATIONS. Final Report. (Rural Cooperative Power Assn., Elk River, Minn.). Apr. 2, 1962. Contract AT(11-1)-651. 22p.

Strength weld integrity and cladding integrity were investigated along with miscellaneous investigations of vessel adequacy. These investigations consisted of a review of all vessel and vessel nozzle extension strength weld radiographs, an ultrasonic inspection of the vessel seam and large nozzle attachment strength welds, destructive testing and analysis of welded-on cladding, vessel flange material

properties tests, and additional stress analyses for several locations in the vessel. It was concluded that the Elk River Reactor pressure vessel can be used for its intended service. Defects revealed in the tests were evaluated using experimental data and professional opinions of the effect of defects of varying magnitudes under the service conditions expected. (M.C.G.)

31737 (WCAP-1832) STUDY OF MERCURY BINARY CYCLES FOR NUCLEAR POWER PLANTS. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). July 31, 1961. Contract AT(30-1)-2176. 228p.

A study was undertaken to evaluate the economic potential and technical feasibility of utilizing a mercury-steam binary power cycle relative to a conventional steam cycle for power generation from large (300 Mw(e) and larger) liquid-metal-cooled reactors. It was concluded that it is technically feasible to utilize a mercury binary power cycle with a sodium-cooled reactor system. The cycle efficiencies of the binary cycles are significantly higher than for steam cycles where the top temperatures of the working fluids are equal. The overall relative economics of the two systems indicated an economic advantage of 0.1 to 0.2 mill/kwh for the binary cycle operating with 1250°F sodium temperature. Conversely at 1000°F sodium temperature the sodium-steam cycle showed a definite superiority. This results from the inability, with designs investigated, to achieve sufficiently high mercury temperatures with 1000°F sodium. (M.C.G.)

31738 (AEC-tr-5890) OPERATIONAL EXPERIENCE WITH THE BR-5 REACTOR. A. I. Leipunskii, O. D. Kazachkovskii, M. S. Pinkhasik, N. N. Aristarkhov, A. V. Karpov, E. P. Larin, and I. A. Efimov. Translated for Atomic Power Development Associates, Inc. from IAEA preprint No. CN-15/40 Presented at the Conference on Operational Experience with Atomic Power Reactors, Vienna, June 4-10, 1963. 28p.

Operation experience of the Russian BR-5 experimental reactor is discussed. Information is given on the repair of the liquid-metal (sodium) loops, operation after reaching the rated burnup of the plutonium, unloading the active zone and removing the fuel element bundles, and decontamination of the sodium loop I. The 5-Mw reactor is sodium cooled, and has a power intensity of 500 kw/l, a neutron flow at the center of the active zone of 10^{15} n/cm^2/sec, and sodium exiting at 500°C. (N.W.R.)

31739 URANIUM REACTORS TO PRODUCE BY-PRODUCTS. Ind. Rev. Africa. Suppl. At. Energy, 46-8 (Apr.-May 1963).

The value of Pu in the British nuclear power program is discussed. The problem of a positive temperature coefficient in reactors fueled with Pu and the use of Pu spikes in natural U-fueled reactors are considered. The research program on the use of Pu in AGR is described briefly. Fast fission breeder reactors are under development. The relationship between Pu-producing and Pu-breeding stations is discussed. (D.L.C.)

31740 WATER-CHEMISTRY PROBLEMS IN WATER-COOLED POWER REACTORS. H. Rabold and W. Schimmel (VEB EPkA, Berlin). Kernenergie, 6: 187-92(May 1963). (In German)

Corrosion and the formation of deposits in the primary circulation system are discussed. The influence of oxygen and pH was investigated. Neutron absorption properties of boric acid were studied. The preparation of water by ion exchange, filtration, and evaporation for various reactors is described. (M.C.G.)

31741 SOME ELECTRICAL EQUIPMENT FOR THE HERO REACTOR. W. G. Harvey. L.S.E. Eng. Bull., 7: Nos. 1-2, 13-20(Mar. 1963).

A description is given of a very simple and straightforward system of rod control used for the HERO reactor, together with details of the instrumentation supplies and electric heating for the gas-flow system. (auth)

31742 COOLANT FLOW CONTROL FOR THE ADVANCED GAS-COOLED REACTOR. G. D. Rix and R. R. Wilson. L.S.E. Eng. Bull., 7: Nos. 1-2, 21-40(Mar. 1963).

The gas circulators and flow-control equipment are an important part of any gas-cooled reactor, being approximately equivalent to the boiler feed plant in a conventional boiler. The 1,500-hp circulator motors for the A.G.R. at Windscale are novel in that they are completely inside the main pressure circuit and operate in carbon dioxide at a pressure of about 20 atmospheres. A description is given of these circulators and the associated pony-motor and vane-control systems, and the importance of the A.G.R. to the future development of the nuclear-power program in Britain is pointed out. (auth)

31743 ANALYSIS OF NUCLEAR REACTOR PERIOD MEASUREMENTS. Laurence L. Moon (Univ. of California, Livermore). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint CPA 63-5124, 23p, $1.00. (UCRL-7277; CONF-4-12)

From Electro-Nuclear Conference, Richland, Wash., Apr. 1963.

A comparison is made of the performance of an analog period-measuring device with statistical limitations. The steady-state accuracy of the device is nearly that predicted by statistical fluctuations at high count rates and actually superior at low count rates. The fluctuations follow a Poisson distribution. The feasibility of digital devices for period measurements is studied in some detail. (D.L.C.)

31744 NUCLEAR FACILITY CONSTRUCTION TECHNIQUES WITH RESPECT TO CONTAINMENT, SHIELDING, AND CLEANLINESS. 12p. (CONF-56-1)

From American Society of Civil Engineers Environmental Engineering Conference, Atlanta, Feb. 1963.

A survey is presented of the techniques used in the construction of nuclear power plants. The philosophy, codes, and construction methods of containment structures are discussed in some detail. Finally, shielding and cleanliness are considered briefly. (D.L.C.)

31745 THE NPD REFUELLING CONTROL SYSTEM. R. A. Ward and G. R. Andrews (Canadian General Electric Co., Ltd., Peterborough, Ont). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint CP 63-710, 9p, $1.00. (CONF-4-1)

From Electro-Nuclear Conference, Richland, Wash., Apr. 1963.

A brief description is given of the over-all fuel-handling system at NPD, giving reactor conditions such as temperature, pressure, and radiation fields. The control system is described in detail, and the use of relays for logic, stepping switches for programmers, removable patchboards for flexibility, and indicating lights for display is covered. Position sensing through pressure boundaries and the use of magnetic dry reed switches and their limitations are discussed. A description of the design approach on logic is given. The fundamental operations of the system fol-

lows, describing the operations as selected by the stepping switches. A brief summary is given of 'on site' operating experience during the past year. (auth)

31746 IMPROVEMENTS IN OR RELATING TO STEAM GENERATING PLANT. Stefan George Bauer and Martin Honess Kendon (to Rolls-Royce Ltd.). British Patent 926,615. May 22, 1963. Filed May 1, 1959.

A steam-generating plant consisting of two steam generators, a common heater to superheat the steam, and a feed-water system is patented. Part of the superheated steam is fed to the generators to evaporate water and to superheat steam, and the other part is fed to one or more locations of use. The feed-water system consists of one normally operative feed-water pump, which delivers to the 2 generators in parallel and receives condensate from the location of use. Each generator has an associated thermopump, in which the superheated steam is expanded through a sonic or supersonic nozzle and then mixed with the steam used for heating purposes in the generator. Methods for controlling the pressure at the inlet of the feed-water pump are provided. Additional features of the invention are described, and one form of steam generating plant embodying the improvements and using a steam-cooled nuclear reactor as the heat source is discussed in detail. (M.P.G.)

31747 IMPROVEMENTS IN OR RELATING TO STEAM GENERATING PLANT. Stefan George Bauer and Martin Honess Kendon (to Rolls-Royce Ltd.). British Patent 926,616. May 22, 1963. Filed May 1, 1959.

A nozzle to expand superheated steam in a steam-generating plant is patented. The nozzle has a large and a small outlet orifice. The smaller orifice is in permanently open communication with the superheated steam from the heat exchanger. Flow to the larger orifice is controlled by a valve between the nozzle and the heat exchanger. The design of the nozzle is described in detail. Advantages of the design include maintenance of an adequate pumping effect even at low steam flow conditions, straightening the flow/pressure rise characteristic at low flows, and, when the heater is a nuclear reactor, maintenance of a small flow of steam through the reactor when it is shut down and cooling. (M.P.G.)

Production Reactors

31748 A REPORT ON THE N-REACTOR FUEL PIECE CHARGING MACHINE. H. D. Lenkersdorfer and G. H. Strong. New York, Institute of Electrical and Electronics Engineers, 1963, Preprint Paper CPA 63-5147, 28p, $1.00. (CONF-4-14)

From Electro-Nuclear Conference, Richland, Wash., Apr. 1963.

A monotube type magazine, once it is aligned and connected to a reactor process tube, provides a fast and gentle means for placing fuel elements in a reactor. However, the machine and associated material handling equipment required to support, align, and load reactors with this type of magazine at rates compatible with the reactor outage time available could be complicated to the point of being difficult to operate and maintain. It is concluded after a year's testing that with proper emphasis during design a multifunction, high-performance charging machine can be built which will be easy to operate and maintain. (auth)

31749 THE NPR MAINTENANCE COMMUNICATION SYSTEM. A. A. Maupin, Jr. New York, Institute of Electrical and Electronics Engineers, 1963, Preprint Paper CPA 63-5134, 4p, $1.00. (CONF-4-5)

From Electro-Nuclear Conference, Richland, Wash., Apr. 1963.

The NPR maintenance communication system essentially consists of an extensive installation of cables and receptacles designed to operate in the common talking mode. Portable master stations are taken to the locations where needed and plugged into the nearest receptacles. Sound powered headsets may be used with the master stations. Conductors are included in the cables to furnish the transistorized master stations with low voltage d-c power. Some of the flexibility of a selective talking system is obtained by including wires for three talking channels in each cable. A separate cable system is installed for each major craft or maintenance function. (auth)

31750 ELECTRICAL ENGINEERING ASPECTS OF NUCLEAR SAFETY. F. D. Robbins (Univ. of Washington, Seattle). New York, Institute of Electrical and Electronics Engineers, 1963, Preprint Paper CP 63-705, 15p, $1.00. (CONF-4-6)

From Electro-Nuclear Conference, Richland, Wash., Apr. 1963.

The status of criteria for reactor safety is discussed briefly. The electrical aspects of reactor power plants are discussed. The HAPO electrical distribution system and the NPR electrical system are described. The interconnection to the BPA power system is also described. Finally, the problems involved in the operation of the NPR electrical system are considered. (D.L.C.)

Research Reactors

31751 (HW-61236(Suppl.5 Rev.)) PLUTONIUM RECYCLE TEST REACTOR FINAL SAFEGUARDS ANALYSIS. SUPPLEMENT 5. FUEL ELEMENT RUPTURE TESTING FACILITY ANALYSIS. H. E. Hanthorn (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1963. Contract AT(45-1)-1350. 79p.

A fuel element rupture testing facility is being installed in the PRTR, with a test section in process channel 1946. The loop will be used to study the effect of jacket ruptures in a variety of fuel elements, including metallic uranium, ceramic, and plutonium-enriched fuels in light water at 600°F and 2100 psig maximum conditions, while the elements are generating at rates up to their full design power. The high coolant temperature is to be achieved by regenerative heat exchange, supplemental electric heat, and heater fuel elements if required. The coolant is circulated by positive displacement pumps. The effluent passes through an ion exchange system to remove particulate and dissolved radioactive materials. Equipment is provided for circulation of decontaminating solutions through the loop. The loop is provided with a safety circuit to protect both the loop and the reactor from off-standard conditions in the loop. The safety circuit is tripped by coolant storage low level, coolant low flow rate in the test section, high or low coolant pressure at the test section inlet, high differential pressure between test section inlet and outlet, or high coolant temperature at the test section outlet. Each function is signaled by three independent sensors, and coincident signals from two are required to trip the safety circuit which scrams the reactor. Other design safety features are provision of a basket tube to contain the intentionally ruptured fuel element and prevent it from damaging the pressure tube, and multiple electrical power and coolant supply backups to ensure an adequate coolant

supply to the test section under all emergency conditions. Installation of the rupture test loop in the reactor in place of a PRTR pressure tube and fuel element has a small positive reactivity effect with fuel in place, and a small negative reactivity effect with no fuel. Loss of light water coolant gives a small, readily controllable, positive reactivity increment of about 0.5 milli-k. The loop can not cause a reactor excursion, and a reactor excursion would not cause an accident in the loop. The loop would have a negligible effect on a reactor maximum credible accident. Rupture of the test section pressure tube is the maximum credible accident to the rupture test loop. This accident does not affect the nuclear safety of the reactor, nor change the radiological consequences of a reactor accident. It could, however, result in some damage to the calandria, and could release contaminants through the calandria vents into the containment vessel. The rupture testing facility was designed to avoid such an accident, and several unusual circumstances must occur sequentially or simultaneously to cause one to occur. (auth)

31752 (IDO-16879) POWER-BURST FACILITY (PBF) CONCEPTUAL DESIGN. A. A. Wasserman, S. O. Johnson, R. E. Heffner, R. S. Kern, and A. H. Spano (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 21, 1963. Contract AT(10-1)-205. 167p.

A description is presented of the conceptual design of a high-performance, pulsed reactor called the Power Burst Facility (PBF). This reactor is designed to generate power bursts with initial asymptotic periods as short as 1 msec, producing energy releases large enough to destroy entire fuel subassemblies placed in a capsule or flow loop mounted in the reactor, all without damage to the reactor itself. It will be used primarily to evaluate the consequences and hazards of very rapid destructive accidents in reactors representing the entire range of current nuclear technology as applied to power generation, propulsion, and testing. It will also be used to carry out detailed studies of nondestructive reactivity feedback mechanisms in the short-period domain. The facility was designed to be sufficiently flexible to accommodate future cores of even more advanced design. The design for the first reactor core is based upon proven technology; hence, completion of the final design of this core will involve no significant development delays. Construction of the PBF is proposed to begin in September 1964, and is expected to take approximately 20 months to complete. (auth)

31753 (IDO-24041(Suppl.1)) DESIGN CRITERIA FOR A FAST FLUX LIQUID METAL LOOP IN THE ADVANCED TEST REACTOR. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. and Ebasco Services, Inc., New York). July 1962. Contract AT(10-1)-1075. 38p.

Design criteria are presented for liquid-metal loop facilities for the Advanced Test Reactor. It was concluded that achievement of the design objectives could not be predicted with any high degree of confidence when utilizing the package loop concept based on the design philosophy of the PW-19 loop. (M.C.G.)

31754 (NASA-TN-D-1731) LEAK-RATE TESTING OF THE NASA PLUM BROOK REACTOR CONTAINMENT VESSEL. Edward G. Keshock and Claude E. DeBogdan (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). July 1963. 33p.

Two methods were used to test the Plum Brook Reactor containment vessel for leakage (the absolute-temperature-pressure method and the reference-system method). Both methods are described and analyzed. Some of the difficulties encountered in tests of this type are investigated and discussed. The results of three leak-rate tests in which both methods were employed simultaneously are presented, and the measurements obtained by both methods are shown to be in substantial agreement. In one of these tests the accuracy of results was verified experimentally by employing a known leak rate. For the Plum Brook Reactor test conditions, the absolute-temperature-pressure method offers greater over-all simplicity than the reference-system method does; however, the reference-system method consistently yielded results having less scatter than the absolute-method results and proved to be an accurate and satisfactory method of measurement. (auth)

31755 (PAEC(D)PH-632) NONDESTRUCTIVE STUDIES ON THE URANIUM DISTRIBUTION OF PRR-I FUEL PLATES. Jose O. Juliano and Pericles T. Meneses (Philippines. Atomic Energy Commission. Atomic Research Center, Manila). Feb. 4, 1963. 9p.

Since it is desirable that all PRR-I fuel elements and/or plates possess even or uniform U^{235} content to prevent the occurrence of hot spots specially when the power of the reactor is raised, two methods are described for inspecting the elements. The two nondestructive methods investigated are: direct counting of gamma activity of U^{235} and U^{238} present in the fuel plates and autoradiography. The fuel plates tested were found to be homogeneous; the maximum standard deviation being 2.5% and the average standard deviation being 1.57%. No major accident due to fuel segregation should therefore be anticipated from these fuel elements. (N.W.R.)

31756 THE SPECTRAL DISTRIBUTION OF EPITHERMAL AND FAST NEUTRONS IN IRRADIATION POSITIONS OF FRM. W. Koehler (Technische Hochschule, Munich). Atomkernenergie, 8: 208-12(June 1963). (In German)

The energy distribution of epithermal and fast neutrons is characterized by the ratio of activities for the irradiation positions in the uranium zone and the graphite reflector. The neutron flux per energy interval was determined for certain assumptions. For the energy interval, where measurements are not possible either with resonance or threshold detectors, interpolation was carried out according to the calculated distribution in the reactor core. For positions in the core and the graphite reflector the extrapolation of the resonance flux and the fast flux up to 0.5 Mev coincided within the margins of error. In the graphite element not adjoining the uranium zone, the effect of the graphite on the epithermal neutron flux was so great that the extrapolation of the measured resonance flux according to the calculated variation for graphite showed better agreement with the extrapolated fast flux. (auth)

31757 ABSOLUTE MEASUREMENT OF THE NEUTRON FLUX DENSITY IN THE A.E.R.E. REACTOR "GLEEP." E. J. Axton (National Physical Lab., Teddington, Middx., Eng.). J. Nucl. Energy, Pt. A & B, 17: 125-35(June 1963). (In English)

The flux density at the sample position of GLEEP is calculated from the activation produced in gold and in manganese-nickel foils. The $4\pi\beta-\gamma$ coincidence technique is shown to be applicable to the absolute measurement of Mn^{56} in foils in spite of the complexity of the decay scheme. The flux density is estimated at 1.663×10^8 n/cm^2/sec per μA of ionization current in the monitor chamber. (auth)

31758 EFFECTIVE FISSION CROSS SECTIONS AND NEUTRON SPECTRA IN AN NRX TYPE URANIUM METAL ROD. C. B. Bigham, S. A. Kushneriuk, and P. R. Tunnicliffe (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 16: 299-314(July 1963).

Fission cross section ratios of U^{233}, U^{235}, and Pu^{239}, and capture rates in Mn^{55} and In^{115}, are measured in an NRX-type uranium-metal rod irradiated in a heavy-water-moderated reactor. The results are compared to values obtained using a model designed for NRX burnup calculations. Agreement is obtained using an "incurrent" spectrum composed of a Maxwellian thermal component and an epithermal component of the form obtained from neutron spectrometer measurements. Changes in spectrum caused by the light water coolant are also studied. (auth)

SPACE APPLICATIONS AND TECHNOLOGY

Refer also to abstracts 30157 and 30944.

31759 (JPL-TR-32-397) FUSION PROPULSION SYSTEM REQUIREMENTS FOR AN INTERSTELLAR PROBE. Dwain F. Spencer (California. Inst. of Tech., Pasadena. Jet Propulsion Lab.). May 15, 1963. Contract NAS-7-100. 14p.

An examination of the engine constraints for a fusion-propelled vehicle indicates that minimum flight times for a probe to a 5 light-year star will be approximately 50 years. The principal restraint on the vehicle is the radiator weight and size necessary to dissipate the heat which enters the chamber walls from the fusion plasma. However, it is interesting, at least theoretically, that the confining magnetic field strength is of reasonable magnitude, 2 to 3×10^5 gauss, and the confinement time is approximately 0.1 sec. (auth)

31760 (MND-P-1175) RADIOISOTOPE FUELED AUXILIARY POWER UNIT. PIED PIPER APU. Quarterly Progress Report No. 3, July 1, 1957–October 1, 1957. (Martin Co., Baltimore). Contract AT(30-3)-217. 51p.

Progress made in the development of SNAP-1 is reported. Drawings of the shielding and remote handling equipment are given. The hazards of this power plant are summarized. The conceptual design of the boiler is revised. The CeO_2 fuel capsules will be mounted in a block of molybdenum by drilling longitudinal holes and inserting. The thermal bond material between the molybdenum block and the mercury bearing coil will be molten lead. Results of studies on fabrication of CeO_2 cermets are given. Equipment for static corrosion testing with mercury and lead is diagramed. Development work on the power conversion system is discussed. (N.W.R.)

31761 (MND-P-3001) RADIOISOTOPE FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 4, October 1957–January 1958. (Martin Co., Baltimore). Contract AT(30-3)-217. 73p.

Work was directed toward building a suitable mercury heat transfer loop that can be operated with a full-size boiler mockup under environmental conditions of both launch and outer space. A new half-power boiler mockup was designed to replace the full-size boiler in the heat transfer test loop. Fuel assembly studies were made on the stabilization of CeO_2 and the oxidation of molybdenum. Corrosion test results on stainless steels, chromium steels, and nickel alloys in contrast with liquid lead, mercury vapor, and liquid mercury are presented. The test rig checkouts were essentially completed and testing was initiated in every area of the power conversion system program. All component groups were directed toward obtaining experimental verification of the individual component designs established for the turbine-alternator dynamometer. (N.W.R.)

31762 (MND-P-3002) RADIOISOTOPE FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 5, January–April 1958. (Martin Co., Baltimore). Contract AT(30-3)-217. 60p.

Progress made in the development of the radioisotope-fueled thermoelectric generator (SNAP-1) is reported. Shipping procedures and the boiler loading and installation philosophy were determined. The core integrity test program was defined in further detail to include tests to evaluate launch abort damage and simulate re-entry heating conditions. A shielding analysis, to facilitate design of the boiler insulation and biological shield, was completed. Assembly of the mockup boiler heat transfer loop was completed and initial testing started. Engineering drawings for the new half-power boiler were completed and fabrication initiated. Development testing continued on CeO_2 pellets to improve stability and corrosion resistance. A corrosion program to determine the effect of biological shield mercury on surface emissivities of insulating metal was initiated. Development of the power conversion system components (turbine, pump, controls, alternator, and bearings) was continued. (N.W.R.)

31763 (MND-P-3003) RADIOISOTOPE FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 6, April 1958–July 1958. (Martin Co., Baltimore). Contract AT(30-3)-217. 125p.

A modular concept has evolved which permits testing of SNAP-1 as an attachable unit. Integrity testing of fuel elements in simulated pad aborts is reported. The adequacy of a full-scale boiler mockup in vaporizing mercury at the design point was tested; a new boiler coil designed to prevent slugging was tested. The sintering properties of CeO_2 were further investigated. Dynamic mercury corrosion testing of Croloy 5 Si and Croloy 5 Ti is reported. Static lead tests of CeO_2 pellets, brazed joints, and flame sprayed coatings continued. Testing of the power conversion system turbine, centrifugal pumps, controls, radial gap alternator, bearings, and steels is described. Design of a facility for testing the APU module is under way. A conceptual design of SNAP-3 was delineated. (N.W.R.)

31764 (MND-P-3004) RADIOISOTOPE FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 7, July–September 1958. (Martin Co., Baltimore). Contract AT(30-3)-217. 116p.

Progress made in the development of SNAP-1 and -3 is reported. SNAP-1 development reported includes: boiler development, fuel development, properties of cerium dioxide, materials corrosion, power conversion system development, shielding analysis, hazards evaluation, and ground test development. SNAP-3 development includes: power conversion analysis, thermoelectric generator development, and fuel element development. Information is given on the handling and transportation equipment for SNAP-1. (N.W.R.)

31765 (N63-16122) ASTRONAUTICS INFORMATION. EFFECTS OF STERILIZING AGENTS ON MICROORGANISMS. Supplement to Literature Search No. 260. Janet Swift, comp. (California. Inst. of Tech., Pasadena. Jet Propulsion Lab.). Mar. 1963. Contract NAS 7-100. 73p.

References are presented on the effects of various sterilizing agents on microorganisms. Emphasis is placed on chemical agents such as ethylene oxide, β-propiolactone, propylene oxide, and ozone. (C.H.)

31766 (TID-17004) THE CESIUM-137 POWER PROGRAM. Quarterly Report No. 3. (Royal Research Corp., Hayward, Calif.). Oct. 31, 1961. Contract AT(04-3)-366. 100p. (RRC-0102)

Progress made in the development of the Cs^{137} fueled thermoelectric generator for marine power applications is reported. Information is given on thermoelectric generator design, shielding, power conversion system, hazards evaluation, fuel element forming and cladding, fabrication, and

heat transfer. Cs^{137} energy calculations are presented along with shielding calculations. The development and fabrication of cesium polyglass for fuel application are included. (N.W.R.)

31767 RADIONUCLIDE POWER SOURCES. J. G. Morse (Martin Marietta Corp., Baltimore). J. Brit. Interplanet. Soc., 19: 87-92(May-June 1963).

A review is given of the fundamental characteristics of power sources in which the decay heat of a radioisotope is converted into electricity by some direct energy conversion device—a thermoelectric converter in present devices. Some work carried out in the U. S. Atomic Energy Commission's SNAP Program is described, including experiments to study operational safety, and particular sources developed for the Transit and communications satellites and for the Surveyor lunar probe. (auth)

31768 THE APPLICATION OF NUCLEAR ENERGY FOR LARGE-SCALE SPACE POWER. B. C. Lindley (C. A. Parsons and Co. Ltd., Newcastle upon Tyne, Eng.). J. Brit. Interplanet. Soc., 19: 92-9(May-June 1963).

Possible types of nuclear reactors and energy convertors suitable for the generation of power in space are surveyed. Estimates of probable performance are given. (auth)

31769 EXPERIMENTAL PERFORMANCE OF A HIGH-CURRENT-DENSITY CYLINDRICAL CONCAVE POROUS TUNGSTEN EMITTER FOR ION THRUSTORS. Joseph F. Wasserbauer (Lewis Research Center, Cleveland). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63029-63, 11p. (CONF-10-13)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The performance of an experimental contact-ionization thrustor with cesium propellant is presented. The porous tungsten ionizer was of cylindrical-concave shape to minimize impingement. The ion thrustor employed focusing electrodes and an accelerating electrode positioned at accelerating distances of 2.00 and 2.50 mm. Current densities as high as 260 amp/m^2 were obtained with accelerator currents of 15 percent of the ionizer current. No recordable accelerator electrode current was obtained for ionizer current densities less than 70 amp/m^2 for an accelerator length of 2.00 mm and net accelerating voltages greater than 4 kv. A comparison is made between the experimental data and the results obtained from a numerical solution of the two-dimensional Poisson equation. Theoretical ion trajectories for a number of configurations are presented. (auth)

31770 ZERO G PROPELLANT FEED SYSTEMS FOR CESIUM ION ROCKET ENGINES. F. A. Barcatta, H. L. Daley, A. H. Firestone, and A. T. Forrester. New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63027, 23p. (CONF-10-12)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Two major problems confront the designer of a propellant feed system for operation in a very low gravity environment. The first and foremost problem is concerned with the establishment of stable liquid-vapor interfaces within the system. This interface normally exists at two positions within the feed system, one being in the main cesium storage reservoir and the other where vaporization of the liquid propellant occurs. The second problem arises from the fact that the flow rates presently of interest in ion propulsion are extremely low. These flow rates, in the region of from 10^{-4} to 10^{-1} grams/sec, make effective vaporization and flow rate metering or control difficult. Two feed system concepts overcoming these problems are under active development for the Air Force at Electro-Optical Systems, Inc. The first of these is the porous vaporizer concept. A bladder storage system is used in which the bladder acts as the interface separator within the reservoir. This system is pressurized and delivers liquid cesium to the porous vaporizer which acts in a triple capacity: (1) as an interface separator, (2) a vaporizer, and (3) the flow controlling element. The flow rate through the vaporizer is strongly dependent upon its temperature, a few degrees change in temperature being sufficient to cause an order of magnitude change in the flow rate. Due to this behavior, very sensitive fast acting control of the flow is possible. The alternate system under development is one which is inherently much more simple and reliable. It has no moving parts. It depends entirely on surface tension forces for the maintenance of liquid-vapor interfaces. Tapered capillaries or a modification in the form of a graded porous sponge provide the driving force necessary to transport the propellant to the vaporizing area. Here again, simple temperature control of the vaporizing area is sufficient to provide a wide range of controlled flow rates. A comparison of the two systems favors the surface tension system from a reliability standpoint although the overall system weight of a comparable porous vaporizer system may be somewhat lighter. (auth)

31771 SUBLIMATION OF TUNGSTEN IN HYDROGEN. G. R. Short and J. M. Howard (Marquardt Corp., Van Nuys, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63024, 18p. (CONF-10-11)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Electrothermal thrustors currently under development will be expected to operate reliably for weeks and months in order to perform appropriate missions. Components such as electrodes and nozzles or heat exchanger surfaces will be operated at temperatures approaching the material limit. Therefore, the sublimation rate of likely refractory materials constitutes important design criteria. The sublimation of tungsten in a hydrogen atmosphere was determined as a function of pressure and temperature. The temperatures used in these experiments were 2800, 3000, and 3200°K, and the hydrogen pressure range was from 0.1 to 7600 mm Hg. It was found that sublimation can be suppressed significantly at a given temperature by an increase in hydrogen pressure. The scope of work includes sublimation in both a static environment and under flow conditions. The experimental data are compared with previously published information based on low pressure inert atmosphere or vacuum experiments. A discussion of the test instrumentation, equipment, and procedures is included. To relate the information on sublimation to practical, contemporary applications, a discussion of the long-term effects of sublimation on the performance of a hypothetical electrothermal engine is presented. (auth)

31772 NASA RESEARCH ON RESISTANCE-HEATED HYDROGEN JETS. John R. Jack and Ernie W. Spisz (Lewis Research Center, Cleveland). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63023, 18p. (CONF-10-10)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Experimental results are presented for two basically different design approaches to the resistance-heated hydrogen thrustor. One thrustor employs a tungsten-tube heat exchanger and is water-cooled, whereas the other uses a

tungsten-wire coil heat exchanger and is radiation-cooled. Data were obtained over an input power range of 0 to 38 kilowatts for propellant flow rates of 10^{-3} lb/sec. A summary of the experimental results follows: 1. For the water-cooled tube heat-exchanger unit at the design power level (30 kw), a specific impulse of 700 seconds was achieved with an overall thrustor efficiency of 36 percent. Sufficient data and experience have now been obtained on the research unit to design a radiation-cooled thrustor for space application with a potential performance of 1000 seconds specific impulse with an efficiency of 75 percent. 2. For the wire-coil unit with an input power of 15 kw, a specific impulse of 710 seconds with an efficiency of 73 percent was attained. This compares to the values of 600 seconds specific impulse and 52 percent efficiency for the tube heat-exchanger model. The higher efficiency of this device demonstrates the expected improved performance of this design approach and indicates the potentially high efficiencies attainable. (auth)

31773 ENERGY ADDITION AND LOSS MECHANISMS IN THE THERMAL ARC JET ENGINE. R. R. John, S. Bennett, L. A. Cass, M. M. Chen, and J. F. Connors (Avco Mfg. Co., Wilmington, Mass.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-022, 45p. (CONF-10-9)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Analytical and experimental results are presented on the energy addition and loss mechanisms within a 30 kilowatt radiation-cooled hydrogen arc jet engine. Photographic observations obtained within the arc engine constrictor section demonstrate the existence of a narrow laminar-like central core flow. The observed core flow diameter (~ 1.5 mm) is in agreement with prediction based on the assumption that the axial mass flux within the central column is negligible. The existence of a non-uniform nozzle throat flow is shown to lead to thrust values larger or smaller than those for uniform nozzle throat flow depending on the spatial distribution of mass flow and power across the nozzle throat plane. The existence of a core flow mechanism of arc engine energy transfer indicates that energy can be transferred to the working fluid with a minimum degree of contact between the arc-heated gases and the engine walls. The energy transfer mechanism to some extent alleviates the arc engine material problem and offers a rational basis for believing that the arc engine still has a considerable specific impulse growth potential. (auth)

31774 COMPUTER SIMULATION OF THE ELECTRON MIXING MECHANISM IN ION PROPULSION. O. Buneman (Stanford Univ., Palo Alto, Calif.) and G. P. Kooyers. New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63042, 19p. (CONF-10-7)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The problem of getting electrons to emerge from an ion engine at the same rate and velocity as the ions was programmed into a computer with certain idealizations such as one-dimensionality (electrons and ions are treated as sheets of charge in mutual Coulomb interaction) and simplified emission conditions (ions are injected with uniform velocity through a plane accel grid, electrons with a thermal distribution from a plane decel grid at ship potential). The ideal thrust seems to be maintained almost steadily, and good spontaneous neutralization seems to take place. It appears to be due to non-static space-charge fields near the electron emitter. These fields automatically admit into the ion stream electrons of approximately the required velocity, and in approximately the right number. Excess electrons are programmed to be absorbed by a fixed grid interception rate. The ship charges up positively but its potential fluctuates rapidly and electrostatic concepts become meaningless: some (0.2 volt) thermal electrons manage to climb fluctuating potential barriers of the order of $\frac{1}{5}$ of the ion energy. Time-displacement graphs of electrons and ions, as well as potential profiles inside and outside the ship, are shown. (auth)

31775 FLOW THROUGH SMALL PORES AS APPLIED TO THE DESIGN OF ION EMITTERS. J. J. Krauss and E. N. Petrick (Kelsey Hayes Co., Romulus, Mich.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63040, 21p. (CONF-10-5)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

In the continuing engineering development aimed toward the improvement of lifetime and reliability in ion engines, the emitter remains one of the critical areas. Inasmuch as some of the prospective missions require that the emitter, which conventionally consists of a sintered porous tungsten disc or strip, function for thousands of hours at high temperatures, an engineering program was initiated to determine the feasibility and characteristics of emitters made from thin solid plates into which holes of the correct dimension have been placed. This type of emitter promises to be more durable and also more precise in regard to hole location and spacing. A brief report is given on the progress to date regarding feasibility of fabricating such emitters and on flow through the small holes. The data are of interest in the design and evaluation of such emitters. (auth)

31776 ELECTRIC PROPULSION REQUIREMENTS FOR PLANETARY AND INTERPLANETARY SPACECRAFT. John W. Stearns (California Inst. of Tech., Pasadena). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63038, 6p. (CONF-10-4)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Assumptions are made concerning the nature of scientific payloads required for planetary exploration missions and the minimum weight of spacecraft necessary to deliver the scientific payload to its destination in deep space. Although it is expected that early scientific exploration of the Moon and of Venus and Mars will be carried out most economically with chemical-propulsion spacecraft, it is suggested that the scientific exploration of the remainder of the solar system could be accomplished most economically through the use of electric propulsion. A single basic spacecraft design with relatively small variation of propellant loading could perform at least nine separate planetary and interplanetary scientific missions beyond Venus and Mars. In addition, with only slight modifications to the basic electric-propulsion spacecraft, it is possible to achieve second-generation orbital missions to Venus and Mars. This spacecraft can use a two-stage Saturn B as a launch vehicle. The parameters for such a mission program are discussed. A 500-kwe powerplant is defined. Finally, ultimate goals for a second-generation nuclear-electric spacecraft are anticipated and basic scheduling criteria are established. (auth)

31777 COMPARISON OF ATTITUDE CONTROL TORQUERS FOR TRANS-ORBITAL MISSIONS. R. L. Ryan and R. A. Clark, Jr. (Westinghouse Astronuclear Lab., Pittsburgh). New York, American Institute of

Aeronautics and Astronautics, 1963, Preprint 63037, 32p. (CONF-10-3)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

In many of the current conceptual designs of electric propulsion spacecraft, electric engines are being proposed as the primary means of supplying vehicle attitude control torques. The choice of electric engines over less complex and presumably more reliable torquing systems, e.g., cold gas, bi-propellant, has been justified by the weight savings inherent in the low thrust, high specific impulse electric engine system. A comparison of available attitude control torquing systems is presented on the basis of weight requirements with reliability also a consideration. A weight penalty is imposed on the vehicle by using high fixed weight electric engine systems for short duration (< 90 day) missions; but, it is apparent that fuel requirements for competing relatively low specific impulse (< 400 sec) systems are eventually going to dictate the use of electric engines as attitude control torquers for certain classes of transorbital missions. However, the crossover point, i.e., the point beyond which electric engine systems demonstrate a clear superiority is not obvious. This study attempts to define this point by considering attitude control torquer system weight for a variety of space missions, chosen to illustrate a generalized approach to the problem. In order to aid in the presentation of a meaningful comparison, the first stage of the study consists of a short discussion of vehicle disturbances with a comparison of their magnitudes and resultant momentum requirements. For example, the estimated magnitude of the disturbances encountered during the geocentric and heliocentric portion of interplanetary missions, e.g., gravitational effects, magnetic fields, solar pressure, etc., are based on a survey of what is considered to be the best available data. Calculations of mission duration times for this study are based on the Irving-Blum method. In making the comparison between systems, the study also attempted to evaluate the effects of over-all system reliability on the ultimate system choice for a given mission. (auth)

31778 A RE-EXAMINATION OF GAS-CYCLE NUCLEAR-ELECTRIC SPACE POWERPLANTS. Jerry Grey and Peter M. Williams (Princeton Univ., N. J.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63036-63, 23p. (CONF-10-2)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Five types of nuclear space power plant cycles are compared: (1) a liquid-metal cycle similar to that of the present SNAP-50, (2) a similar cycle, but using in-pile thermionic diodes instead of turbomachinery, (3) a conventional Brayton (gas) cycle, (4) a similar gas cycle, but using in-pile thermionic diodes, and (5) a new "split-radiator gas cycle." Results of these analyses are presented in parametric form, in which specific radiator weights are given at the one-megawatt level as functions of peak cycle temperature, thermionic cell efficiency, and minimum radiator temperature. The gas cycle using in-pile diodes is strongly favored by the results of the comparison, but mechanical and radiation damage considerations lead to serious contemplation of the split-radiator cycle. In this cycle, an inert gas is heated to very high temperatures (~ 3300°F) in the reactor and is cooled by a radiator, composed of thermionic diode elements, to acceptable turbine inlet temperatures. The balance of the cycle is then similar to a conventional Brayton cycle, with the turbine used only to drive the compressor. Possible cycle variations discussed include regeneration and the use of a conventional turbogenerator to supplement the thermionic powerplant output. Ideal heat transfer is assumed in all cycles. Results of these performance estimates, coupled with the qualitative considerations, indicate that the gas cycles can no longer be excluded by the liquid-metal cycle for consideration in space-nuclear power plants. (auth)

31779 NEED ELECTRIC PROPULSION WAIT FOR THE DEVELOPMENT OF NUCLEAR POWER SOURCES? R. N. Olson and R. A. Boucher (Hughes Aircraft Co., Culver City, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63035, 27p. (CONF-10-1)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Presented is a preliminary design of a Solar Electric Test Satellite (SETS) system to be used for scientific mission applications. In addition to having the capability of accomplishing the electric rocket engine tests, the vehicle can accommodate a scientific package weighing up to 150 pounds, and it provides orientation control and data storage capabilities commensurate with the requirements for scientific experiments such as magnetic and radiation surveys of the upper atmosphere. The system presented uses the Thor-Agena B launch vehicle, utilizes solar cells for primary power, has a three-axis cold-gas attitude control system for the spacecraft proper, and an independent two-axis power gimbal drive attitude control system for the scientific package. An on-board high-density magnetic tape storage system is provided with a data storage capacity in excess of 11,000,000 bits. The design test mission provides for 90 days or more of useful test time divided among as many as four test electric rocket engines. Shortly after Agena separation at 300 nautical miles, the solar panels will be deployed, and the vehicle will be stabilized and oriented in preparation for engine tests. The initial orbit will be a twilight orbit inclined 97.7° so as to precess eastward about the polar axis 1° per day to keep the vehicle in view of the sun. As the electric engines are operated, the orbit will be raised at a rate of 10 to 25 miles per day, depending on the thrust level of the particular engine being tested. This change of orbital altitude, however, will cause the precession rate to diminish and thus limit available test time before the vehicle enters the earth's shadow. At an initial orbital altitude of 300 nautical miles and an engine thrust of 0.01 pound, the vehicle will remain out of the earth's shadow for about 150 days. All test data are stored and can be read out once every 12 hours as the vehicle passes over a convenient Minitrack ground station. (auth)

31780 INVESTIGATION OF RF NOISE GENERATION FROM SPACE VEHICLES. H. L. Wiser and R. D. Wanselow (Hughes Research Labs., Malibu, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63054, 11p. (CONF-10-28)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Investigations on cesium contact ion engines exhibited no r-f noise from the ion exhaust beam over the 38 to 2200 Mc spectrum at power levels down to − 90 dBm/Mc. The engines tested were operated under pulsed and continuous beam conditions, both with and without an electron neutralizer. Tests of the Penning discharge engine indicate that noise can be expected to radiate in the frequency spectrum near the electron cyclotron and electron plasma frequencies. Several effects reduce the noise from an ion engine seen by a receiver aboard a space vehicle. One major

effect is that the plasma appears to radiate as a line source seen almost end on. Many of the noise mechanisms studied have a cutoff frequency at which the noise per cycle bandwidth begins to decrease, either gradually or very sharply. Therefore, reliable communications systems with a vehicle involving a Penning discharge engine should probably be operated above the electron cyclotron and plasma frequencies. Analytical studies of a possible noise growth mechanism over a narrow band about the electron plasma frequency indicate that it may be possible to generate r-f interference, although this has not been verified experimentally. Another possible detectable noise source is generation by electron radiation from plasma boundary accelerations. However, the expected power level of this type of radiation probably will be too low to cause interference with present-day receivers. (auth)

31781 PROBLEMS OF MILLIPOUND THRUST MEASUREMENT. THE "HANSEN SUSPENSION." David G. Carta (California Inst. of Tech., Pasadena). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63034-63, 7p. (CONF-10-23)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The system considered is the so-called "Hansen Suspension" by which the best measurements to date of millipounds of thrust have taken place. Measurements of thrust in the millipound region with a sigma of 1% were found repeatable and practical. Considered in detail are problems which led to the need and use of the "Hansen Suspension." Also discussed are problems which are likely to be encountered in any low-level thrust measuring system. The method of calibration and the accuracies involved are given careful attention. With all parameters optimized and calibration techniques perfected, the system was found capable of a resolution of 10 μlb. A comparison of thrust measurements made by the "Hansen Suspension" with measurements of a less sophisticated device leads to some surprising results. (auth)

31782 PROTECTION REQUIREMENTS FOR THE RESISTANCE OF METEORITE PENETRATION OF INTERPLANETARY SPACECRAFT SYSTEMS. John J. Volkoff (California Inst. of Tech., Pasadena). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63059-63, 16p. (CONF-10-21)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

A study of spacecraft component and system protection requirements for the resistance of meteorite penetration damage is presented for various interplanetary missions. The meteoroid flux, nature, and distribution are discussed. A micrometeoroid model derived for this study includes the expected micrometeoroid flux distribution in planetary, asteroid belt, and spatial regions. Various selected interplanetary missions for nuclear-powered spacecraft include missions extending from solar probes to Saturn orbiters and Pluto probes. Shown are their respective trajectories and extensively varying micrometeoroid flux profiles which have been determined from the meteoroid model. Most conventional armor requirement estimate techniques offered are shown to be inapplicable for interplanetary missions. A technique to estimate the armor requirement for any interplanetary mission is developed and fully discussed. The armor requirement for interplanetary missions is compared to that for near-Earth conventional estimates. The results of this study are applied to the radiator systems of a selected conceptual 500-kwe nuclear-electric spacecraft capable of all the designated interplanetary missions. Tube-element optimum configuration and panel segmentation schemes are discussed. (auth)

31783 ELECTRIC BREAKDOWN AND ARCING IN EXPERIMENTAL ION THRUSTOR SYSTEMS. John B. Stover (Lewis Research Center, Cleveland). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63057-63, 16p. (CONF-10-20)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The importance of breakdown and arcing phenomena in ion thrustors arises both from the necessity to cluster modules to obtain useful thrust levels and from the probable advantages of the electrical paralleling of modules on a minimum number of power supplies. An experimental program was undertaken to identify the breakdown and arcing phenomena in an electron-bombardment ion thrustor. Breakdown between the accelerating electrodes was observed below the levels determined by other investigators for either field emission from clean surfaces or sparking with surfaces contaminated by vacuum-pump oil, and well below the withstand voltage of the insulators. Following breakdown, self-extinction of low-current arcs frequently occurred, as expected from published reports on the instability of d-c vacuum arcs. A considerable percentage of the breakdowns, however, developed into sustained arcing. The low breakdown potential and the persistence of some low-current arcs both suggest the presence of contaminants on the electrodes. Luminous prebreakdown discharges observed at the electrodes tend to confirm the presence of contaminants. (auth)

31784 PLASMA-VEHICLE INTERACTION IN A PLASMA STREAM. David F. Hall, R. F. Kemp, and J. M. Sellen, Jr. (Space Technology Labs., Inc., Redondo Beach, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63055, 63p. (CONF-10-18)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

Results are presented of an analytical and experimental examination of the plasma-vehicle interaction. For that condition in which the vehicle is stationary within the plasma, the fields and potentials and the currents to the vehicle are calculable from conventional Langmuir probe theory. It was shown that the perturbed region in the plasma may extend outward from the vehicle over distances which are many times greater than the size of the vehicle. It was also noted that the electric field strength on the surface of the vehicle may be, at a given vehicle potential, greatly enhanced because of the near termination of the lines of electrical force from the vehicle surface. When the vehicle velocity becomes comparable to, or greater than, the ionic velocity, the simple calculational treatment is no longer valid. Under these conditions, an experimental examination using a vehicle in a plasma stream was undertaken. The potentials in the plasma were examined and demonstrated this increasing zone of disturbance as the potential difference between the vehicle and the plasma is increased. The geometry of this perturbed region is no longer simply spherically symmetric and is complicated in its behavior, particularly in the directions to the rear of the vehicle. Using a second experimental array, the ion flow patterns in this downstream region were examined. For small negative vehicle potentials this downstream region has preserved the "shadow" cast by the vehicle in the plasma stream. For increasing negative vehicle potentials, the lens effects of

the electric fields from the vehicle have produced ion current peaks in the center of this formerly shadowed region, with an increasing area of diminished ion flow away from these current peaks. The current flow to the vehicle surface for these negative vehicle potentials demonstrated the onset of intercepted ions to the backward hemisphere and demonstrated a structure in the flow pattern in the forward direction. These flow patterns were examined at lesser and greater plasma densities, and demonstrated a less complicated structure at the lower density. A final series of measurements was made of the electric field strength on the vehicle surface. The enhancement of this electric field strength was measured and the dependence of this enhancement upon plasma density, vehicle potential, and position on the vehicle surface was studied. This enhancement was demonstrated to be considerably more complex than in the calculable, stationary plasma case. While the experiments were performed with variations in several of the parameters of the plasma-vehicle system, it is obvious, from a catalog of these quantities, that the variations have not yet exhausted all the possible conditions in the system. The plasma density, the ion mass, and velocity, the electron temperature, the vehicle radius and potential, and the three positional coordinates in the plasma are all quantities which enter into a detailed specification of the interaction. From the involved nature of the system, it would appear that a wholly analytical treatment is presented with formidable difficulties. It was demonstrated, however, that a duplication of this plasma-vehicle system may be set up within the laboratory and one may examine this interaction in detail. This use of a plasma wind tunnel parallels, in a sense, the earlier, conventional aerodynamic tunnel, with the exception that the fluid in which the vehicle moves is no longer the usual aerodynamic environment, but rather, the dilute resident plasma of space. (auth)

31785 AN ELECTRON-BOMBARDMENT ION ROCKET WITH A PERMANENT MAGNET. Paul D. Reader (Lewis Research Center, Cleveland). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63031-63, 7p. (CONF-10-16)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The electron-bombardment ion sources investigated to date normally employ a magnetic field to contain the energetic primary electrons and thus enhance the ion production process. A solenoidal winding is usually used to produce this containment field. A program was undertaken to determine the feasibility of utilizing a permanent magnet circuit to provide the magnetic field of the shape and strength required for the efficient operation of a low-current-density electron-bombardment ion rocket. The method used to design the magnetic circuitry is described. An experimental comparison of ion chamber efficiency (i.e., ev/beam ion) is made between the permanent-magnet and solenoid types. Experimental flight-type designs for both magnetic field systems are compared for total weight and system requirements. The permanent magnet circuit is a reliable, mechanically strong, and efficient replacement for the solenoid on the electron-bombardment thrustor. The circuit can be designed to yield total thrustor weights comparable to units with flight-weight solenoid coils, in addition to eliminating the weight of the power supply and controls required by the field windings. The permanent magnets serve as a return path for the magnetic flux lines, which substantially reduces the field external to the thrustor. The use of this concept for flight hardware will enhance the simplicity and reliability of the thrustor system. (auth)

31786 ANALYTIC CONSIDERATIONS RELATED TO THE LEWIS TYPE BOMBARDMENT ION ENGINE. Ira Kohlberg (Ion Physics Corp., Burlington, Mass.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63030-B-63, 13p. (CONF-10-15)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

An exploratory, theoretical model was developed to determine the regions of weak and strong plasma; and, in addition, was used to predict the radial shape of both plasma density and electrostatic potential. The electron distribution function was calculated for Hg under an assumed weak plasma condition which showed that the electron temperature, T_f, varied as $(E/B)^2$ with estimated values ranging from 250,000 to 400,000°K. Experimental results gave at times a slight increase of T_f with B with measured values in the 60,000 to 90,000°K range. Consequently, based on this variance, the arc did not operate as a weak plasma. The kinetic model for the arc utilized both a primary electron group and a Maxwellian group which evolved from ionization and elastic slowing down of the primaries. The radial potential, V(r), and plasma density, N(r), were calculated by developing a modification of ambipolar diffusion theory. The results gave $N(r) = N_0 J_0(\gamma r)$, and $V(r) = V_0 \ln N$ + constant, where γ depends upon a number of operational parameters. It was found that relatively small adjustment in the calculated value of γ could bring the theoretical and experimental N(r)'s into agreement for average plasma densities greater than 10^{11} cm^{-3}. The uncertainties in the measurement of V(r) precluded comparison of this quantity. (auth)

31787 STUDIES OF A LEWIS TYPE BOMBARDMENT ION ENGINE. H. J. King and B. S. Quintal (Ion Physics Corp., Burlington, Mass.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63030A-63, 5p. (CONF-10-14)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

An experimental program was conducted to investigate the performance of a Lewis Type electron bombardment ion engine. It was found that, depending on the fixed operating parameters, either the arc density or the beam-forming electrode geometry limits the allowable output current. A similar type of operation was found for engines varying in diameter by a factor of three, indicating that the engine size may be scaled if required to produce a particular output thrust or to match the power output of a generator. Thrust pulses of duration 50 msec were produced with a rise time of the order of 10 μsec by pulsing the arc voltage. No deleterious effects were observed as a result of operating the engine in a pulsed mode. (auth)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 30071, 30072, 30073, 30074, and 30089.

31788 (CONF-49-1) FISSION PRODUCT RECOVERY FROM WASTE SOLUTIONS BY SOLVENT EXTRACTION. D. E. Horner, D. J. Crouse, K. B. Brown, and B. Weaver (Oak Ridge National Lab., Tenn.). [1962]. Contract [W-7405-eng-26]. 44p.

From International Symposium on Unit Process in Hydrometallurgy, Dallas, Feb. 1963.

Solvent-extraction techniques for recovering fission products from reactor fuel process waste liquors are discussed. Topics covered include composition of feed liquors, experimental techniques, recovery of strontium and rare earths, promethium and rare earth separations, cesium recovery, zirconium–niobium recovery, and aqueous feed pretreatment with amines. A flowsheet for the techniques described is presented. (M.C.G.)

31789 (ORO-603) ION EXCHANGE TREATMENT OF LOW-LEVEL RADIOACTIVE WATER IN WHICH BICARBONATE IS THE PREDOMINANT ANION. I. R. Higgins and C. G. Phillippi (Chemical Separations Corp., Oak Ridge, Tenn.). Feb. 27, 1963. Contract AT(40-1)-2979. 47p.

Fixed-bed and continuous ion-exchange flowsheets were developed for treating low-radioactivity-level process water. By using a combination of weak-acid and strong-acid type ion-exchange resins with bicarbonate waters, it was possible to use nitric acid regenerant stoichiometrically. The resulting waste without evaporation was a neutral nitrate salt about 2N in strength. Evaporation was recommended so the resulting waste would be a mass of crystals rather than liquid. Decontamination of Cs^{137} and Sr^{90} was about 10^3 even when fluoride was 10 ppm and polyphosphate 5 ppm. About 95% of the rare earths was removed when these complexing agents were absent but none when present. A ¾ million gallon per day plant was cost estimated as follows for water 100 ppm in hardness and 23 ppm sodium in cents per 1000 gallons: capital 5.5¢ and operating 34¢, including solid waste disposal. (auth)

31790 (ORO-604) DEVELOPMENT OF A PROCESS FOR CONTINUOUS PHENOLIC ION EXCHANGE TREATMENT OF ALKALINE INTERMEDIATE RADIOACTIVE-LEVEL WASTES. I. R. Higgins, C. G. Phillippi, and J. D. Jones (Chemical Separations Corp., Oak Ridge, Tenn.). Feb. 28, 1963. Contract AT(40-1)-2979. 46p.

A continuous ion exchange process was developed for the treatment of neutralized stored radioactive waste supernate solution in order to save space. The process makes use of the high affinity of phenolic cation exchange resin for cesium, strontium, and rare earths in the presence of massive concentrations of sodium in alkaline solution. Decontamination factors of 10^3 and 10^4 were demonstrated using Duolite S-30 resin and a sodium removal of greater than 99%. The process requires meager chemical consumption, and an operating cost of about 10¢ per gallon is estimated. (auth)

31791 (PAEC(D)HP-631) ECOLOGICAL SURVEY. A Preliminary Report. Benito C. Bernardo and Edilberto A. Cabalfin (Philippines. Atomic Energy Commission. Atomic Research Center, Manila). Mar. 1963. 12p.

The Philippine Atomic Research Center proposes to dispose of low level liquid waste in Culiat Creek. Results are presented from an ecological survey of the Creek. Certain plants and animals that are found to be present in the creek at all times will be selected to serve as biological monitors of radioactivity levels. (C.H.)

31792 EXPERIMENT ON THE SOLIDIFICATION OF RADIOACTIVE CONTAMINATED WASTE BY MEANS OF INGLOBING IN CONCRETE BLOCKS. Guido Branca (CNEN, Rome), Paseuale D'Elia, and Luigi Mendia. Ing. Sanit., No. 3, 12p.(1962). (RT/PROT(63)2). (In Italian)

Some of the processes used on the water treatment are sometimes usefully adopted for the removal of the radioactivity from low-level contaminated wastes. The radionuclides are removed from the liquid phase and transferred in the sludges, which are formed by the processes themselves. The methods actually used for the contaminated sludges' disposal are mentioned. The migration of the radionuclides from the sludges to the external environment is the basic danger connected with the disposal of such sludges; a particular method to avoid this danger consists in making the sludges themselves insoluble. Research was undertaken in order to find the most appropriate technique to avoid the solubility of the sludges by inglobing them in concrete cement blocks. The experiments were carried in two successive runs, the first testing sludges with 97.5% of humidity, the second with sludges of 85% of humidity. As binder, the 550 slag cement was used, limestone being the inert material. This study concerns the concrete's characteristics and the loss of the accumulated radioactivity. The presence of sludges, independent of their degree of humidity, did not appear to have altered the general characteristics of the concrete. The most favorable composition was found to consist of small inert particles. The loss of radioactivity, during the first cycle, was found to be approximatively 0.1%, while during the second cycle the radioactivity was found to be 0.2% of the original activity initially measured in the concrete. The loss of radioactivity rapidly diminished during the successive immersions. The above seems to indicate that leaching is pertinent only of the upper layer of the specimen. Other experiments shall be conducted with other nuclides and other types of concrete, consisting of pozzuolana, and with siliceous inerts. (auth)

CORPORATE AUTHOR INDEX

This index contains entries for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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ä	becomes	ae
ö		oe
ø		oe
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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

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All reports, translations, and patents abstracted in this issue are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show, when known, which reports are on file in the depository libraries, which reports have been published in open-literature journals (journal citation given), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, cross references from secondary to primary report numbers are cited.

The report number codes apply to AEC reports unless designated otherwise. Non-AEC reports are identified by parenthetical notes after the report codes; e.g., (non-AEC), (British), (Canadian), (French). The note (Misc.) identifies those codes used for both USAEC and non-AEC reports. The report numbers for the non-AEC reports in these series are marked with an asterisk (*). Patents are listed under the heading "PATENTS"; the country of origin is included in parentheses.

A comprehensive listing of both AEC and non-AEC report codes is contained in TID-85(2nd Rev.), *Report Number Series Used by the Technical Information Service in Cataloging Reports*. March 1960, $2.75 (OTS), and supplement, August 1960, $0.50 (OTS).

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Abbreviations Used in Availability Column

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Gmelin	Available at a nominal charge and under the AED- number shown from Atomic Energy Documentation Center, Gmelin Institute, 40-42 Varrentrappstrasse, Frankfurt (Main), West Germany.

GPO	For sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C.
HMSO	Her Majesty's Stationery Office, London.
IAEA	Available from the International Atomic Energy Agency.
JCL	For sale by the Special Libraries Association Translation Center, John Crerar Library, 86 E. Randolph Street, Chicago 1, Illinois.
NAS	National Academy of Sciences, National Research Council, Washington 25, D. C.
NRC	For sale by the National Research Council of Canada, Ottawa, Ontario, Canada.
ORINS	Available on interlibrary loan from the Library, Oak Ridge Institute of Nuclear Studies, Post Office Box 117, Oak Ridge, Tennessee 37831
OTS	For sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C.
UKAEA, London	Available from United Kingdom Atomic Energy Authority, 11 Charles II Street, London, S. W. 1.
USGS	Available free-of-charge from the U. S. Geological Survey, Washington 25, D. C.

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6903	17-31511	Phys. Rev., 131: 1624-32(1963)
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29	17-31242	ORINS. New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63017
CONF-12	**(8th Annual Meeting, American Nuclear Society, Boston, June 1962)**	
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5	17-30946	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-046-2
CONF-51–	**(American Public Power Association Annual Convention, Cleveland, April–May 1963)**	
4	17-31722	Dep.(mc); $3.60(fs), $1.40(mf) OTS; Gmelin, AED-CONF-63-047-1
CONF-52–	**(2nd International Conference on Nuclidic Masses, Vienna, July 1963)**	
1	17-31406	See IS-695
CONF-53–	**(1962 World Metal Show, New York, New York, Oct. 29–Nov. 2, 1962)**	
1	17-30955	ORINS
2	17-31010	ORINS
CONF-56–	**(American Society of Civil Engineers Environmental Engineering Conference, Atlanta, February 1963)**	
1	17-31744	ORINS. Gmelin, AED-CONF-1963-010-4
CONF-58–	**(Institute of Electrical and Electronics Engineers International Convention, New York, March 1963)**	
1	17-31051	ORINS. Gmelin, AED-CONF-1963-034-1
CONF-59–	**(ASM Western Metal Congress, Los Angeles, March 1963)**	
1	17-31012	ORINS. Gmelin, AED-CONF-1963-037-1
CONF-60–	**(WESCON, Institute of Electrical and Electronics Engineers, San Francisco, August 1963)**	
1	17-30857	See UCRL-10887
CONF-62–	**(3rd Conference on Reactions Between Complex Nuclei, Asilomar, Calif., April 1963)**	
2	17-31542	ORINS. Gmelin, AED-CONF-63-054-7
8	17-31399	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-054-6
9	17-31400	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-054-8
CONF-65–	**(Federation of American Societies for Experimental Biology Meeting, Atlantic City, N. J., April 1963)**	
6	17-30280	Dep.(mc); $3.60(fs), $1.16(mf) OTS; Gmelin, AED-CONF-63-052-10
CONF-70–	**(National Symposium of the Professional Technical Group on Microwave Theory and Techniques, Santa Monica, Calif., May 1963)**	
1	17-31627	ORINS. Gmelin, AED-CONF-63-069-1
CONF-72–	**(Transplutonium Element Symposium, Argonne, Ill., May 1963)**	
1	17-30507	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-062-2
2	17-30625	ORINS. Gmelin, AED-CONF-63-062-1
CONF-73–	**(Sixth Biennial Conference on Carbon, Univ. of Pittsburgh, June 1963)**	
1	17-31036	ORINS. Gmelin, AED-CONF-63-061-2
2	17-30931	ORINS
CONF-74–	**(ASTM Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963)**	
2	17-30838	ORINS. Gmelin, AED-CONF-63-050-14
3	17-30837	ORINS. Gmelin, AED-CONF-63-050-6
4	17-30225	ORINS. Gmelin, AED-CONF-63-050-12
5	17-30835	ORINS. Gmelin, AED-CONF-63-050-9
CONF-77–	**(Symposium on Plasma Space Science, Washington, D. C., June 1963)**	
1	17-31258	ORINS. Gmelin, AED-CONF-63-051-7
CREL–	**(Canadian)**	
1145	17-30798	Dep.(mc); $1.00(AECL)
CU–	**(Misc.)**	
224	17-31279	See NEVIS-118
CU(PNPL)–		
228	17-31077	Dep.(mc); $4.60(fs), $1.58(mf) OTS
D–	**(Misc.)**	
1-82-0216*	17-31245	
DLCS–		
3410114	17-31723	Dep.(mc); $8.60(fs), $3.14(mf) OTS
3410117	17-31724	Dep.(mc); $8.10(fs), $2.75(mf) OTS
DMIC-Memo–	**(Non-AEC)**	
166	17-30947	$3.60(OTS) as AD-41538
DP–		
793	17-31676	Dep.; $0.75(OTS)
802	17-30908	Dep.; $0.50(OTS)
830	17-31725	Dep.; $2.50(OTS)

Report No.	Abstract No.	Availability
DRCL–	**(Canadian)**	
405	17-30312	Can. J. Biochem. Physiol., 41: 1525-30 (1963)
DRI–	**(Misc.)**	
2059	17-30969	Dep.(mc); $6.60(fs), $2.09(mf) OTS
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EACRP-U–	**(Swiss)**	
2	17-31672	See AEEW-R-249
3	17-31671	See AEEW-R-233
EANDC(E)–	**(European-American Nuclear Data Committee)**	
39L	17-31401	Dep.(mc)
EUR–	**(European Atomic Energy Community)**	
222.f	17-30850	Dep.(mc)
EUR-CEA–	**(European Atomic Energy Community)**	
FC-197	17-30851	Dep.(mc)
EURAEC–		
68	17-31677	See GEAP-3771-1
706	17-30906	See BMI-1633
713	17-30905	See ARF-B198-42
723	17-30911	See NCSC-2663-12
725	17-30963	See ATL-A-136
740	17-31673	See BMI-X-10051
741	17-30964	See BMI-X-10050
FTD-TT–	**(Non-AEC)**	
63-258	17-30988	OTS
63-496	17-30636	OTS
GA–	**(Misc.)**	
2881	17-30909	Dep.; $0.50(OTS)
3053	17-31726	Dep.; $2.25(OTS)
3578	17-31593	J. Nucl. Energy, Pt. C, 5: 161-7(1963)
3985	17-30508	Dep.; $0.75(OTS)
4002	17-31727	Dep.(mc); $10.10(fs), $4.04(mf) OTS
4202*	17-31570	
4267	17-31019	Dep.(mc); $3.60(fs), $1.28(mf) OTS
4285*	17-31571	
GAMD–	**(Misc.)**	
2100(Rev.)	17-31728	Dep.(mc); $4.60(fs), $1.70(mf) OTS
GAT-T–		
1118	17-30470	Dep.(mc); $1.60(fs), $0.80(mf) OTS
1120	17-30471	Dep.(mc); $1.10(fs), $0.80(mf) OTS
GEAP–	**(Misc.)**	
3653	17-30948	Dep.; $1.00(OTS)
3743(Pt.I)	17-31020	Dep.; $1.25(OTS)
3755	17-30659	Dep.(mc); $6.60(fs), $2.27(mf) OTS
3771-1	17-31677	Dep.(mc); $3.60(fs), $1.25(mf) OTS
3957	17-31678	Dep.(mc); $12.00(fs), $5.03(mf) OTS
4020	17-30936	Dep.; $1.50(OTS)
4158	17-31679	Dep.; $1.75(OTS)
4222	17-30852	Dep.; $0.75(OTS)
4272	17-31729	Dep.(mc); $9.60(fs), $3.65(mf) OTS
4275	17-30660	Dep.(mc); $2.60(fs), $0.92(mf) OTS
GEMP–		
24A	17-30910	Dep.; $0.75(OTS)
GEST–	**(Misc.)**	
2015*	17-30970	

Report No.	Abstract No.	Availability
HMI-B–	**(German)**	
25	17-30509	Dep.(mc)
HTL-TR–		
52	17-30665	See TID-19090
HW–		
61236(Suppl.5 Rev.)	17-31751	Dep.; $1.75(OTS)
65173(Rev.)	17-30661	Dep.; $0.75(OTS)
71359	17-30853	$1.10(fs), $0.80(mf) OTS
75278	17-31680	Dep.; $1.00(OTS)
76553(Rev.)	17-30749	Dep.(mc); $1.10(fs), $0.80(mf) OTS
76559	17-31681	Dep.; $2.50(OTS)
76692	17-30901	Dep.; $1.50(OTS)
77311	17-31078	Dep.; $1.25(OTS)
77533	17-30750	Dep.; $0.75(OTS)
77963	17-30751	Dep.(mc); $9.60(fs), $3.53(mf) OTS
78288	17-31384	Dep.(mc); $1.60(fs), $0.80(mf) OTS
HW-SA–		
2772	17-30662	Dep.(mc); $1.60(fs), $0.80(mf) OTS
IA–	**(Non-AEC)**	
822	17-29879	Dep.(mc)
IDO–		
12030	17-30752	Dep.(mc); $2.60(fs), $1.01(mf) OTS
14611	17-30582	Dep.; $1.00(OTS)
16879	17-31752	Dep.; $2.75(OTS)
24041(Suppl.1)	17-31753	Dep.; $1.00(OTS)
IITRI–	**(Misc.)**	
A6027-3	17-31402	Dep.(mc); $3.60(fs), $1.22(mf) OTS
A6042-1	17-31682	Dep.(mc); $3.60(fs), $1.25(mf) OTS
B6007-3*	17-30971	
IMP-AEC–		
23	17-31116	J. Chem. Phys., 38: 1808-26(1963)
INSJ–	**(Japanese)**	
56	17-31403	Dep.(mc)
57	17-31404	Dep.(mc)
58	17-31405	Dep.(mc)
IPPJ–	**(Japanese)**	
7	17-31572	Dep.(mc)
9	17-31573	Dep.(mc)
IS–		
578	17-30510	Dep.; $1.25(OTS)
695	17-31406	Dep.(mc); $1.60(fs), $0.80(mf) OTS
ITR–	**(Misc.)**	
1174	17-29883	Superseded by WT-1174
JEN–	**(Spanish)**	
114-DF/I-33	17-31385	Dep.(mc)
115-DF/I-34	17-31683	Dep.(mc)
120-DF/I-37	17-31407	Dep.(mc)
JINR–	**(Russian)**	
E-1268	17-31276	Dep.(mc)
P-1260	17-31277	Dep.(mc)
P-1264	17-31082	Dep.(mc)
P-1272	17-31278	Dep.(mc)
JPL-TR–	**(Non-AEC)**	
32-397	17-31759	
JPRS–	**(Non-AEC)**	

Report No.	Abstract No.	Availability
20129	17-30785	$0.50(OTS)
20210	17-30293	$0.50(OTS)
JüL–	**(German)**	
108-RX	17-30460	Kaeltetechnik, 14: 399-403(1962)
KAPL–		
2286	17-30972	Dep.(mc); $1.60(fs), $0.80(mf) OTS
KFK–	**(German)**	
145	17-30257	Akad. Wiss. Lit. (Mainz), Abhand. Math.-Nat. Kl., 1962, No. 14, 1025-38(1962)
LA–		
2827	17-31083	Dep.; $4.00(OTS)
2912	17-30973	Dep.; $0.50(OTS)
LADC–		
4806	17-31617	See TID-12331
5632	17-31503	Phys. Rev., 131: 1232-43
5726	17-31662	Phys. Rev., 131: 1869-80(1963)
5821	17-31408	Dep.(mc); $6.60(fs), $2.12(mf) OTS
LAMS–		
2906	17-30974	Dep.; $0.50(OTS)
2911	17-31574	Dep.; $0.50(OTS)
LNF–	**(Italian)**	
63/34	17-31552	Dep.(mc)
63/35	17-30854	Dep.(mc)
63/38	17-31553	Dep.(mc)
MATT–		
174	17-31608	Phys. Rev. Letters, 10: 465-7(1963)
194	17-31575	Dep.(mc); $3.60(fs), $1.22(mf) OTS
MLM–		
1158	17-30583	Dep.; $0.50(OTS)
MND-P–		
1175	17-31760	Dep.(mc); $5.60(fs), $1.73(mf) OTS
3001	17-31761	Dep.(mc); $7.60(fs), $2.39(mf) OTS
3002	17-31762	Dep.(mc); $5.60(fs), $2.00(mf) OTS
3003	17-31763	Dep.(mc); $10.10(fs), $3.95(mf) OTS
3004	17-31764	Dep.(mc); $9.60(fs), $3.68(mf) OTS
MPR-XIII–		
6-63	17-30664	See TID-19089
MSAR–	**(Misc.)**	
63-19*	17-30753	
N–	**(Misc.)**	
63-16122*	17-31765	$7.60(fs), $2.42(mf) OTS
NAA-SR–		
8235	17-30511	Dep.; $0.50(OTS)
8412	17-30949	Dep.; $0.75(OTS)
8468	17-31730	Dep.; $0.75(OTS)
NAA-SR-Memo–		
2908	17-31731	Dep.(mc); $2.60(fs), $0.92(mf) OTS
8195(Rev.)	17-30754	Dep.(mc); $5.60(fs), $1.79(mf) OTS
8247	17-31684	Dep.(mc); $4.60(fs), $1.43(mf) OTS
8513	17-31685	Dep.(mc); $1.60(fs), $0.80(mf) OTS
8516	17-31634	Dep.(mc); $9.60(fs), $3.71(mf) OTS
8522	17-31267	Dep.(mc); $2.60(fs), $1.07(mf) OTS
8581	17-31686	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NASA-TN–	**(Misc.)**	
D-1731*	17-31754	$1.00(OTS)
NASA-TR–	**(Non-AEC)**	
R-177	17-31246	
NCSC–	**(Misc.)**	
2663-12	17-30911	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NEVIS–	**(Misc.)**	
118	17-31279	Dep.(mc); $8.60(fs), $3.11(mf) OTS
NIRL-LN–	**(British)**	
3	17-31280	Dep.(mc)
NIRL-R–	**(British)**	
28	17-31554	Dep.(mc)
33	17-31555	Dep.(mc); $0.77(BIS); 5s. 6d. (HMSO)
36	17-31556	Dep.(mc)
37	17-31557	Dep.(mc)
NLCO–		
880	17-30512	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NMI–	**(Misc.)**	
1256	17-30976	Dep.(mc); $6.60(fs), $2.21(mf) OTS
2117	17-30950	Dep.(mc); $3.60(fs), $1.25(mf) OTS
2118	17-30912	Dep.(mc); $2.60(fs), $1.07(mf) OTS
4992	17-30975	Dep.; $1.75(OTS)
NP–	**(AEC File No. for Non-AEC Reports)**	
12961	17-30634	
12962	17-31021	
12964	17-30951	
12965	17-31409	
12966	17-31084	
12968	17-30937	
12969	17-30977	
12970	17-31085	
12971	17-30938	
12972	17-30913	OTS
12973	17-30914	
12974	17-30915	$6.60(OTS) as AD-413032
12975	17-31640	Dep.(mc)
12976	17-31576	
12977	17-30287	
12988	17-31086	
12992	17-31087	
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
1025	17-31581	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
NPCC-FEWP–	**(British)**	
(63) P57	17-30986	See TNPG-401
NRC–	**(Canadian)**	
7391	17-30520	Can. J. Phys., 1174-92(1963)
7484	17-31106	Can. J. Phys., 41: 1193-1225(1963)
NUMEC-P–		
54	17-30916	Dep.(mc); $1.10(fs), $0.80(mf) OTS
55	17-30983	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NYO–		
6550	17-30617	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6551	17-30618	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6552	17-30619	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6553	17-30620	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6555	17-30621	Dep.(mc); $2.60(fs), $0.86(mf) OTS
8772	17-30895	Dep.(mc); $4.60(fs), $1.61(mf) OTS
10257	17-31349	Phys. Rev., 131: 1822-5(1963)
10285	17-31687	Dep.(mc); $5.60(fs), $1.94(mf) OTS
10462	17-31088	$3.60(fs), $1.40(mf) OTS

Report No.	Abstract No.	Availability
ORA–	**(Misc.)**	
03763-12P	17-31559	See TID-19016
ORNL–		
3325	17-31577	Dep.; $0.75(OTS)
3405	17-30855	Dep.; $0.50(OTS)
3431	17-31558	Dep.; $2.00(OTS)
3448	17-30675	Dep.; $2.60(fs), $1.10(mf) OTS
3466	17-31635	Dep.; $2.00(OTS)
3467	17-31281	Dep.; $0.75(OTS)
3471	17-30513	Dep.; $1.10(fs), $0.80(mf) OTS
ORNL-TM–		
584	17-30783	Dep.(mc); $1.10(fs), $0.80(mf) OTS
631	17-30566	Dep.(mc); $1.10(fs), $0.80(mf) OTS
ORO–		
603	17-31789	Dep.(mc); $4.60(fs), $1.61(mf) OTS
604	17-31790	Dep.(mc); $4.60(fs), $1.58(mf) OTS
OTS–	**(Misc.)**	
63-31261*	17-30785	For translation see JPRS-20129
63-31307*	17-30293	For translation see JPRS-20210
PAEC(D)HP–	**(Philippines)**	
631	17-31791	Dep.(mc)
PAEC(D)PH–	**(Philippines)**	
632	17-31755	Dep.(mc)
PAN–	**(Polish)**	
384/VII	17-31654	Dep.
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
923,546	17-30649	
924,733	17-30674	
924,748	17-31700	
924,811	17-30564	
924,970	17-30650	
924,999	17-31701	
925,000	17-31702	
925,122	17-31703	
925,154	17-31704	
925,465	17-31069	
925,505	17-31638	
925,508	17-30651	
925,629	17-30890	
925,702	17-31705	
925,923	17-30896	
926,006	17-31639	
926,073	17-30933	
926,152	17-31706	
926,170	17-30891	
926,292	17-30934	
926,302	17-30779	
926,488	17-30897	
926,605	17-31707	
926,615	17-31746	
926,616	17-31747	
926,728	17-30652	
926,939	17-30892	
927,225	17-30780	
927,285	17-30653	
927,331	17-30654	
927,359	17-31708	
927,392	17-31070	
927,492	17-30678	
927,519	17-30611	
927,522	17-30841	
927,539	17-31709	
930,058	17-31710	
930,070	17-31711	
930,170	17-30842	
930,326	17-30655	
930,360	17-30656	
930,370	17-30781	
930,421	17-30612	
930,422	17-30956	
930,600	17-31712	
930,606	17-30898	
930,624	17-31713	
930,638	17-31714	
930,641	17-30657	
PATENTS	**(U. S.)**	
3,090,670	17-30935	
3,091,695	17-30747	
3,091,847	17-31715	
3,095,267	17-30565	
3,096,220	17-30945	
3,096,263	17-31716	
3,096,269	17-31630	
3,096,411	17-30843	
3,096,438	17-31631	
3,097,543	17-30658	
3,097,630	17-31717	
3,097,920	17-30630	
3,097,960	17-30793	
3,098,020	17-30899	
3,098,022	17-30957	
3,098,023	17-31718	
3,098,024	17-31719	
3,098,025	17-30958	
3,098,028	17-30959	
3,098,154	17-30844	
3,098,156	17-30893	
3,098,709	17-30631	
3,098,807	17-30960	
3,098,812	17-31720	
3,098,944	17-30894	
PATENTS	**(U.S.S.R.)**	
141,912	17-30845	
143,982	17-30636	For translation see FTD-TT-63-496
148,551	17-31632	
PG-Report–	**(British)**	
395	17-30514	Dep.
481	17-30472	Dep.
483	17-30473	Dep.
PNE–	**(Misc.)**	
104F	17-31089	Dep.; $0.50(OTS)
PUC–		
1963-110	17-31282	Dep.(mc); $19.75(fs), $9.25(mf) OTS
PWAC–	**(Misc.)**	
370(Suppl. 1)	17-31732	Dep.(mc); $4.60(fs), $1.55(mf) OTS
R–	**(Misc.)**	
374	17-31279	See NEVIS-118
RISÖ–	**(Danish)**	
58	17-30984	Dep.(mc)
RME–		
4543	17-30679	Dep.; $0.50(OTS)
4567(Rev.)	17-30680	Dep.; $0.50(OTS)
RRC–		
0102	17-31766	See TID-17004

Report No.	Abstract No.	Availability
RT-BIO–	**(Italian)**	
(63)7	17-30302	Atti. Congr. Nazl. Radiobiol. Med., VI, Trieste, 1962, 26-8(1963)
(63)9	17-30314	Caryologia, 15: 279-91(1962)
(63)10	17-30301	Atti. Accad. Econ.-Agrar. Georgofili Firenze, (7), 9: 1-23(1962)
(63)12	17-30285	Pubbl. Staz. Zool. Napoli, 32: 400-26(1962)
(63)13	17-30334	Pubbl. Centro Sper. Agr. Forest., 6: 119-29(1962)
RT-CHI–	**(Italian)**	
(62)15	17-30303	Atti. Uffic. Congr. Sci., Sez. Nucl., 1960, 573-82(1962)
RT/GEO–	**(Italian)**	
(63)7	17-30283	Atti. Soc. Toscana Sci. Nat. Pisa, Proc. Verbali Mem., Ser. A, No. 2, 3-7(1962)
(63)16	17-30727	Studi Ric. Div. Geomineraria, Comit. Nazl. Ric. Nucl., 3: 219-56(1960)
(63)20	17-30728	Studi Ric. Div. Geomineraria, Comit. Nazl. Ric. Nucl., 3: 354-86(1960)
RT-PROT–	**(Italian)**	
(63)2	17-31792	Ing. Sanit., No. 3, 12p. (1962)
SAM-TDR–	**(Non-AEC)**	
63-1	17-30755	$1.10(OTS)
63-21	17-30856	$1.60(OTS)
SB–	**(Non-AEC)**	
63-9	17-30913	See NP-12972
SC–	**(Misc.)**	
4920(M)	17-30917	Dep.(mc); $8.60(fs), $3.06(mf) OTS
SCDC–		
3057	17-31139	See TID-17955
3257	17-30518	See TID-18932
SCTM–		
71-57(14)	17-31090	Dep.(mc); $7.60(fs), $2.48(mf) OTS
144-63(24)	17-30799	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SRO–		
84	17-31733	Dep.(mc); $1.10(fs), $0.80(mf) OTS
SSD-TDR–	**(Non-AEC)**	
63-120	17-31578	$5.60(OTS)
STI-PUB–	**(International Atomic Energy Agency)**	
68	17-30730	$8.50; 178.50s; NF 34; DM 29.80(IAEA)
SY–	**(Non-AEC)**	
5396-R4	17-30939	
TID–		
3556(Rev.2)	17-31734	Dep.; $2.50(OTS)
4200	17-30226	Dep.; $1.00(OTS)
7025(Suppl.1)	17-31735	Dep.; $3.50(OTS)
12331	17-31617	Temp. Meas. Control Sci. Ind., 3: Pt. 1, 663: 78(1962)
13704	17-29935	Proc. Japan Conf. Radioisotopes, 4th: 434-45(1961)
14401	17-30018	Proc. Japan Conf. Radioisotopes, 4th: 977-8(1961)
14932	17-31646	See NP-12975(p.82-92)
17004	17-31766	Dep.(mc); $8.60(fs), $3.20(mf) OTS
17375	17-30902	Dep.(mc); $3.60(fs), $1.13(mf) OTS
17600	17-30234	Lab. Animal Care, 13: 5p. (1963)
17601	17-30236	Lab. Animal Care, 13: 25-35(1963)
17955	17-31139	J. Math. Phys. (N.Y.), 4: 897-900(1963)
18036	17-30782	Dep.(mc); $4.60(fs), $1.64(mf) OTS
18168	17-31123	J. Chem. Phys., 38: 2599-2609(1963)
18171	17-30537	J. Chem. Phys., 38: 2620-6(1963)
18322	17-31688	Dep.; $2.50(OTS)
18354	17-31188	Phys. Rev., 131: 1087-1101(1963)
18443	17-30746	p.395-411 of "Radioactive Dating," Vienna, IAEA, 1963.
18655	17-31368	Phys. Rev. Letters, 10: 50-2(1963)
18702	17-31204	Phys. Rev., 131: 1500-10(1963)
18811	17-31175	Phys. Rev., 131: 932-48(1963)
18813	17-30756	Dep.(mc); $15.00(fs), $7.04(mf) OTS
18902	17-31334	Phys. Rev., 131: 1290-1302(1963)
18932	17-30518	Appl. Phys. Letters, 3: 35-6(1963)
18940	17-31363	Phys. Rev. Letters, 10: 35-6(1963)
18955	17-30584	Dep.(mc); $4.60(fs), $1.58(mf) OTS
18974	17-31283	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18993	17-30757	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18997	17-30800	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19009	17-30676	Dep.(mc); $2.60(fs), $0.95(mf) OTS
19010	17-30288	Dep.(mc); $8.10(fs), $2.66(mf) OTS
19012	17-30515	Dep.(mc); $3.60(fs), $1.25(mf) OTS
19015	17-30784	Dep.(mc); $4.60(fs), $1.61(mf) OTS
19016	17-31559	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19017	17-30801	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19018	17-30903	Dep.(mc); $4.60(fs), $1.61(mf) OTS
19026	17-31736	Dep.(mc); $2.60(fs), $0.86(mf) OTS
19028	17-31268	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19029	17-30663	Dep.(mc); $3.60(fs), $1.16(mf) OTS
19030	17-30802	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19041	17-30400	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19049	17-30289	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19051	17-31410	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19053	17-30227	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19058	17-30290	Dep.(mc); $5.60(fs), $1.73(mf) OTS
19070	17-30985	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19072	17-31284	Dep.(mc); $3.60(fs), $1.28(mf) OTS
19073	17-31285	Dep.(mc); $2.60(fs), $0.95(mf) OTS
19076	17-31286	$2.60(fs), $1.04(mf) OTS
19080	17-30516	Dep.(mc); $2.60(fs), $0.89(mf) OTS
19082	17-31287	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19083	17-31288	Dep.(mc); $4.60(fs), $1.55(mf) OTS
19086	17-30228	$1.60(fs), $0.80(mf) OTS
19089	17-30664	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19090	17-30665	Dep.(mc); $5.60(fs), $1.82(mf) OTS
19092	17-30635	Dep.(mc); $2.60(fs), $0.89(mf) OTS
19100	17-30229	Dep.(mc); $4.60(fs), $1.70(mf) OTS
19102	17-30517	Dep.(mc); $2.60(fs), $0.92(mf) OTS
19104	17-30281	Dep.(mc); $5.60(fs), $1.73(mf) OTS
19105	17-31289	Dep.(mc); $1.60(fs), $0.80(mf) OTS
TM–	**(Misc.)**	
63-1-6	17-30946	See CONF-50-5
63-5-4	17-30968	See CONF-50-4
TNPG–	**(British)**	
401	17-30986	Dep.(mc)
TR–	**(Misc.)**	
63-461.10*	17-30937	See NP-12968
TRG-Inf. Ser.–	**(British)**	
310	17-30989	Dep.; $2.60(fs), $0.86(mf) JCL
TRG-Report–	**(Non-AEC)**	
535(S/X)	17-30986	See TNPG-401
UAC–		
7102	17-30537	See TID-18171
7236	17-31188	See TID-18354
UCRL–		

Report No.	Abstract No.	Availability
4047	17-31636	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6954	17-31195	Phys. Rev., 131: 1165-9(1963)
7277	17-31743	See CONF-4-12
7333	17-31483	Phys. Letters, 5: 136-7(1963)
10329	17-31518	Phys. Rev., 131: 1712-22(1963)
10396	17-31560	Dep.; $2.25(OTS)
10496	17-31525	Phys. Rev., 131: 1765-81(1963)
10571	17-31510	Phys. Rev., 131: 1586-8(1963)
10613	17-31561	Dep.; $0.50(OTS)
10632	17-31332	Phys. Rev., 131: 1276-86(1963)
10633	17-31333	Phys. Rev., 131: 1287-9(1963)
10743	17-30230	Dep.; $2.25(OTS)
10747	17-31411	Dep.; $2.00(OTS)
10836	17-31529	Phys. Rev. Letters, 10: 23-6(1963)
10837	17-31360	Phys. Rev. Letters, 10: 268(1963)
10862	17-31091	Dep.; $2.00(OTS)
10887	17-30857	Dep.(mc); $2.60(fs), $0.86(mf) OTS
UCRL-Trans-		
923(L)	17-31092	Dep.(mc); $1.60(fs), $0.80(mf) JCL
UR-		
626	17-30291	Dep.; $2.75(OTS)
USNRDL-TR-	**(Non-AEC)**	
649	17-30858	$1.10(OTS) as AD-410158
VEC-	**(British)**	
1	17-31556	See NIRL/R/36
4	17-31554	See NIRL/R/28
5	17-31557	See NIRL/R-37
WAPD-T-		
1554	17-31029	Nucl. Sci. Eng., 16: 315-28(1963)
WCAP-	**(Misc.)**	
1832	17-31737	Dep.; $3.00(OTS)
1997(Rev.2)	17-30666	Dep.(mc); $4.60(fs), $1.61(mf) OTS
2128	17-30859	Dep.(mc); $1.60(fs), $0.80(mf) OTS
WRU-		
110	17-30292	Dep.(mc); $2.60(fs), $0.98(mf) OTS
WT-	**(Misc.)**	
801	17-29880	Dep.(mc); $4.60(fs), $1.67(mf) OTS
808*	17-30758	Dep.(mc); $1.60(fs), $0.80(mf) OTS
810	17-29881	Dep.(mc); $2.60(fs), $0.83(mf) OTS
1162	17-29882	Dep.(mc); $4.60(fs), $1.58(mf) OTS
1174	17-29883	Dep.(mc); $7.60(fs), $2.57(mf) OTS
1501	17-29884	Dep.(mc); $8.10(fs), $2.81(mf) OTS